SKELETAL EVIDENCE OF THE SOCIAL PERSONA

Life, death and society in early medieval Alamannic communities

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ABSTRACT

Skeletal evidence of the social persona. Life, death and society in early medieval Alamannic communities

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Historic-archaeological research on the Alamanni, an early medieval population in the periphery of the Frankish Empire, primarily focuses on themes such as their military character or issues of ethnicity, while the actual functioning of Alamannic societies remains conjectural. Aiming at presenting an integrated approach to the concepts of social organisation and social identities in Alamannic populations, this study examines and defines Alamannic identity and society by creating a dialogue between the disciplines of archaeology, biological anthropology and socio-cultural sciences.

A bioarchaeology of identity explores the Alamanni of Pleidelsheim and Neresheim via their funerary and skeletal evidence, allowing for the factor of different environments that influence the interactions of a community. A key theme is the investigation of indicators for biological and social "status", by direct association of bioanthropological with funerary archaeological data, as well as by evaluation of

present interpretations made from material culture in the light of bioanthropological analysis as a paramount focus. The results are interpreted in terms of social status and the perception of certain social parameters, exploring interrelations between factors such as sex and gender, age, status and activity for the entirety of a society.

This research offers new perspectives on Alamannic societies and helps to comprehend Alamannic social organisation as a multi-layered phenomenon, emphasizing the importance of a biocultural approach. Beyond common perceptions, this study forms the basis for a new understanding of the Alamanni, as the results reveal a society that was complex and diverse, displaying its own characteristics in the Merovingian world.

Doctoral Committee

Professor Ian Armit (principal supervisor)

Professor Christopher J. Knüsel

Professor Carl Heron

DEDICATION

“Don’t be more specific in the diagnosis than the evidence makes possible.”

For Donald J. Ortner (1939 - 2012), who taught me to observe and to carry on, to be scholarly, curious and ever inspired by the people of the past and present.

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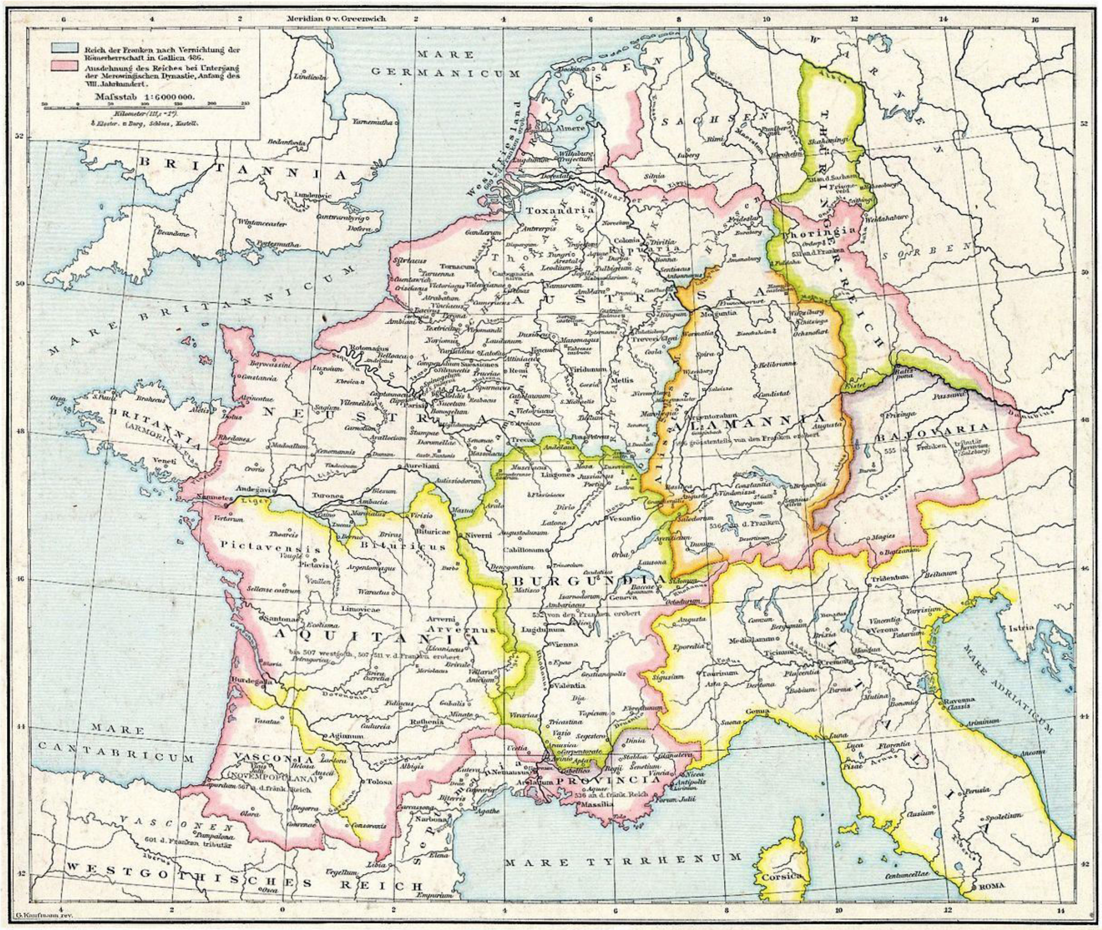

Fig 1.1: The *Alamannia* in the Frankish kingdom under the Merovingians (Source: Droysen, JG (1886); http://de.wikipedia.org/w/index.php?title=Datei:Frankenreich_unter_den_Merowingern.jpg&filetimestamp=20110827191302).

"One has no identity apart from society; one has no individuality apart from identity."
Nelson N. Foote, *Identification as a basis for a theory of motivation*

1 Introduction

At the beginning of a chapter on "Society" of the early Alamanni the author J. Drinkwater remarks, *"Other than that their warriors had long hair, dyed red, and liked strong drink we know little about them."* (Drinkwater 2007: 117). What seems like a strong statement, considering the seemingly vast amounts of textual and archaeological evidence on Late Roman, Migration Period and Merovingian Europe, is an unvarnished reflection of the current state of knowledge regarding the socio - cultural world of this early medieval population altogether, and condenses the heart of the matter regarding the common characterisation of the Alamanni. Ostensibly straightforward, Alamannic cemeteries appear to tell us about their life and death, yet by and large, astoundingly little is known about the identity of these people who lived on the fringes of the Frankish Empire, in a region called '*Alamannia*' located between the Rhine and the Roman *Limes* (Fig. 1.1). This starts with what they actually called themselves and continues with inferences on their lives and times as gathered from what could be described as circumstantial evidence, with a distinct and satisfactory insight into this early medieval population still outstanding.

To archaeologically investigate the Alamanni today is to investigate a population whose name, as much as the name of the area they inhabited, is a creation of etic views and external powers. Their identity is shrouded in a fabric comprised of historical narration, Roman concepts of the "Barbarians", Frankish concepts of the law, socio-historical impositions of 19^{th} century thought and a deeply rooted admiration for the status-conscious Franks, as well as archaeologically inductive approaches to identifying a population that moves beyond the scope of classification and categorization. Despite the great abundance of cemetery evidence, Alamannic life and death, social organisation, and identity are poorly understood, leaving "*the Alamanni*" generally gridlocked as "not the Franks".

It is the mode of research undertaken on the Alamanni that poses the fundamental problem: existing archaeological and culture-historical research for this period is largely focussed on either the military character of the Alamanni or on issues of ethnicity, considering the Migration Period context from which the Alamanni emerged. The actual social functioning of these societies, especially regarding the multitude of different customs and influences, is only interpreted via material culture, with many interrelations unrecognised or speculative. Despite vast numbers of burials, the use of osteological data is scant, and merely used to supplement archaeological interpretations, while considerations on society, social life and identities are not taken beyond basic levels of epistemological enquiry. To date, there has been very little concern about how to approach Alamannic life as an entity in its own right, an indispensable step for understanding the social complexity of this culture.

The present study aims at an integrated approach to the concepts of social organisation and 'social identities' in two Alamannic populations dating to the early 5th to late 7th century AD and situated in different environmental as well as geopolitical settings of the '*Alamannia*'. It focuses on anthropological and bioarchaeological evidence and brings together osteological, archaeological and historical research in order to arrive at an understanding of interrelations between funerary and skeletal evidence as descriptors for the lives and functioning of past populations. Exploring interrelations between social constructions via a combination of funerary and skeletal evidence is essential to understanding Alamannic social organisation, by definition a multi-layered phenomenon. The current state of research bespeaks the need for the integration of bioanthropological data to clarify current debates surrounding social identity since studies of material culture alone cannot illuminate the social dynamics for this period.

The main objectives of this study are:

- to investigate indicators of biological and social status through integration of osteological and archaeological data (i.e. a bioarchaeological approach);
- to evaluate present interpretations of Alamannic culture, with bioanthropological analysis as a paramount focus by analysis of skeletal remains of two populations and a reconstruction of their possible lifeways;
- to interpret the results in terms of social status and the perception of social parameters based on interrelations of sex, gender, age-at-death, health status, well-being (i.e. growth and development) and activity to define and scrutinize social identity;
- to compare bioanthropological and archaeological interpretations of social dynamics, and how the integrated approach changes our understanding of early medieval communities.

To address this purpose, this thesis is organised into seven chapters, taking its starting point with the cultural and chronological framework of the Alamanni (Chapter 2), outlining the current state of knowledge of the Alamanni and introducing prevailing perceptions, hypotheses and premises on their life and times as well as social organisation. An exploration of the societal, ideological and theoretical framework for this study follows in Chapter 3, surveying the complexities of early medieval societal structures as well as social identities and their relevance to the study of the Alamanni. This chapter reflects upon how the dichotomy of life and death and the correlations between biological and social "status" can be investigated most efficiently and bioarchaeological analysis be used to complement and advance archaeological and historic research. With the materials and methods set out in Chapter 4, the results of the analysis of archaeological and skeletal data are presented in Chapters 5 to 7: firstly, the burial evidence is analysed and evaluated with regard to biological age and sex, with patterns of deposition, their chronological change, as well as the meaning of specific grave goods for gender and age identity and, consequently, the Alamannic life course, being explored. Secondly, patterns of skeletal health and, thirdly, of activity-related changes are analysed and juxtaposed against archaeological variables in order to explore bioarchaeological indicators for social variability and to establish a matrix for social differentiations within and between the cemeteries. Chapter 8 provides the interpretation of the findings and characterizes the two Alamannic societies in the light of the mortuary ritual and physical evidence of the body, discussing the material constructions of death and deciphering the meanings of display with regard to social identities and organisation, and exploring Alamannic life course and lifestyles.

It is hoped that this interdisciplinary approach will provide a more comprehensive picture of Alamannic society and lifeways, contribute to unravelling social complexity in the *Alamannia* and illuminate the significance of social identities, their visibility in early medieval burials and their meaning for the reconstruction of social organisation during a period of decentralized power and changes occurring with the onset of kingdoms.

"One of the most difficult - strictly speaking, impossible - things for historians to recapture is a sense of what people did not *know at the time."*
T. G. Ash, *Facts are Subversive*

2 The Alamanni - 'warriors, peasants, and all men'?

2.1 Who were they?

2.1.1 Historiography and archaeology of the Alamanni

When it is said that often the past is made in the present, this certainly applies to the exploration of the lives and times of the Alamanni. In endeavours to explore and understand the Alamanni, historians and archaeologists primarily availed themselves of sources from authors who were unfamiliar with the Alamanni on a first hand basis, instead reporting on what they thought they know, or what they wanted to be known. There are no written records by the Alamanni, except for a few runic inscriptions (Wood 1998a: 372); the most important written sources mentioning the Alamanni are either (late) Roman or Frankish (Dirlmeier and Gottlieb 1976; 1978 ; Hummer 1998b). The first focus on aspects of warfare and the Alamanni as a 'Barbarian' group (a "motley crowd", Asinius Quadratus (Dirlmeier and Gottlieb 1978: 80)) with great strength on the battlefield and a keen interest in fighting and raiding, so, for instance, Tacitus in his *Germania* (Lund 1988), or Ammianus Marcellinus, who includes a considerable number of descriptions on "the Alamanni"[1] and their leaders (Drinkwater 2007: 177). Frankish sources (for

[1] The inverted commas are apposite here, as Ammianus, strictly speaking, described the members of the communities that lived in the area of the Alamannia, at a time when the formation of the Alamanni as characterised in this study would still have been in very early stages.

instance, Gregory of Tours, late 6th century[2]; hereafter: *Greg. Tur.*) integrate the Alamanni into the history of the Franks, or, in official capacity (7th and 8th century law codes), constitute a command by the Merovingian kingdom onto one of its provinces. Thus, Alamannic identity *per se* is shaped by the perceptions of outsiders. Since it may indeed be one of the more difficult tasks to gain knowledge about the "unwritten Alamanni", scholarship moves on a basis that is heavily influenced by an historiography which is mostly concerned with military aspects, with the detection of élites in early medieval societies, with investigating polarities in the populations of early medieval Europe (i.e., for instance, Franks versus Alamanni, Romans versus Barbarians, Merovingians versus Barbarians [3] (e.g. Theuws 2009)), and an archaeological approach that tries to extrapolate information on Alamannic social structure and, to a much lesser extent, lives, from a combination of historical studies and the analysis and interpretation of material culture. In traditional Merovingian archaeology and historical research (cf. Martin 2002 ; Effros 2003), much more so than in Anglophone studies, scholars preferred to adhere to what is described as the '*grand narrative'*: the idea of culture as a consistent and almost uniform entity (Hedeager 2000) with regard to customs, values or norms, that is shared by societies or even populations (Theuws 2000: 2f.). As Theuws (2000: 3) states, "Culture was seen as a set of preconceived conditions and ideas, historically given, to which individual members of that society had to adhere and which gave them their identity." The main interest was not in identifying the particularities of

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[2] Gregory of Tours described in his *Historiarum libri decem* (Buchner 2000a; 2000b; Tours 1974) in narrative form and centered around the Frankish nobility political events and social fabrics of the late 6th century. It is believed that his works have been re-edited repeatedly (Halsall 2005), yet they are the subject of much interpretation and discussion regarding the Merovingian world. The Alamanni are mentioned as the opponents of Clovis who first show great strength in battle in 496 AD, but then turn and run away once Clovis seeks God's help to defeat them (Greg. Tur. *Hist.* II. 30).

[3] These binary constructs "oversimplify the complexities of changing ritual repertoires in changing societies." (Theuws 2009: 284).

Alamannic culture and society, but exploring how people of the Alamannia, the Merovingian kingdom in general, as well as of *Germania Libera* contributed to the Migration period processes in early medieval Europe (the "Age of the Great Invasions", James 1980) and the formation of later civilisations. The rise of the Frankish empire and its expansion and powers through dynasties, alliances, victorious warfare and acculturation constitutes a phenomenon in early medieval Europe[4] (e.g. Halsall 2001 ; Van Dam 2005 ; Theuws 2009: 314). Thus, literary sources and funerary archaeology, i.e. first and foremost the material evidence due to its potential for classification and the construction of typologies that could be used for categorizing periods, people, cultures, and their produce (Martin 2002), were (and often still are) used to underpin the paragon "of Frankish sophistication and strength" (Drinkwater 2007: 348).

Archaeological research on the Alamanni tends to historicize its interpretations, due to similarity between Frankish and Alamannic cemeteries during the 5th to 7th centuries, paying little attention to a very different socio-historical context that requires different interpretations. Given the scarcity of knowledge about the Alamanni in these centuries, the classical tradition of German archaeology has led historians to create a picture of this period through hypothetical additions to the historical sources (Koch 2001: 17). Contrary to Anglophone theory on mortuary archaeology, originating in prehistoric archaeology and going through several paradigm shifts over time, the German approach originated in protohistoric archaeology (Härke 2000), with significant interest in matters of ethnic identity, of

[4] Indeed, following 19th century mentality: "Romains et Franks, l'esprit de discipline civile et les instincts violents de la barbarie, voilà le double spectacle et le double sujet d'étude qu'offrent les hommes et les choses au commencement de notre histoire. C'est là ce qu'avant tout il faut décrire nettement, ce qu'il faut montrer sous toutes ses faces et avec toutes ses nuances, pour qu'une opinion définitive, une conviction universelle se forme à l'égard de nos origines sociales." (Thierry 1842: 193).

religion, and of social differences that could be inferred from funerary material culture (Härke 1997d; 2000). A main concern of the early archaeology on the Alamanni, still largely sustained today despite differences between the acknowledgement of the rhetorics of text, material evidence and social practice (Theuws 2009), was to find an agreement between the written sources and archaeological material finds (e.g. Veeck 1931). Thus emerged one of the main characterisations of the Alamanni: it seems a well-known fact that warfare was of great importance for Alamannic society, following late Antique descriptions (Drinkwater 2007: 121f.), and that Alamannic society was violent, characteristic of 'Barbarian' societies in general (Drinkwater 2007: 121) and Germanic society in particular (Hedeager 1993: 122f.). In combination with the widespread presence of the weapon burial custom in Alamannic cemeteries, considered originally a Germanic rite[5], this lead to the interpretation of all Alamannic men - at all times - as warriors or men able to fight (e.g. Hübener 1977 ; Steuer 1997). Not only does this demonstrate the unreserved conferment of descriptive traits onto an entire population, regardless of socio-political space and time[6], but the fairly simplistic tallying of one part of the population with indicators emerging from the burial rite. The question of what daily life looked like for those men in their society remained unanswered, apart from the facile deduction that if they did not fight, they must have been peasants, hence coining the term 'peasant - warriors' (Duby 1984 ; Steuer 1997). The uncertainty about Alamannic life and society beyond the foreign textual descriptions extends onto women and children, as well as onto those levels

[5] The weapon burial custom is believed to have emerged in the early first millennium AD (Härke 1997c: 120).

[6] The "urge" to be violent, fight and raid, is considered to have emerged from a state of chronic insecurity about social and political conditions in the Northern European areas during late Antiquity (Drinkwater 2007: 121). It remains to be questioned whether this would have continued to apply to the people settling and living in the Alamannia throughout the centuries, up to Carolingian rule (9th century).

of society that did not present a high quantity of valuable grave goods in their burials and therefore could not offer sufficient or any informational value regarding the social organisation of the population, save the fact that they were “the poor”, and hence contribute to a desired ‘élite historiography’[7]. As this study seeks to explore the Alamanni, including all members of society and reflecting the individuals within their local and changing societies (Theuws 2009), the question arises of who “the Alamanni” really were, what, in all the sources and investigations on Merovingian life and times, can be found about these people that defines the socio-cultural framework.

How difficult it is to define “the Alamanni” in the first place, with regard to an understanding of the social complexities of the population in focus, is exemplified in the study of the Alamanni beyond the identification as ‘Barbarians’ and their formation as a group or *gens* (Geuenich 2009), i.e. of Alamannic ethnogenesis, a field of much interest regarding the effects of the Migration Period on the peoples of central Europe (Hummer 1998b ; Brather and Wotzka 2006). In 289 AD, we find the first mentioning of the name “Alamanni” as a ‘Barbarian’ tribe of Germanic descent in a Latin panegyric[8] (Drinkwater 2007: 44), disputably named as a tribe against which Caracalla fought in 213 AD (Bleckmann 2002 ; Johne 2006: 258; Drinkwater 2007: 44). It is likely that the name described something about them, as it was the case for the Franks (“the audacious”, “the free”), namely either “all men” or “the entirety of the Mannus - gender” (Haubrichs 2002: 19ff.; Rübekeil 2004:

[7] Ausenda (1998: 402) criticises the contempt of many historians with regard to “lowly material details” and emphasises how it is the seemingly unimportant details and simple grave goods that may point to social complexities and transitions.
[8] *Pan. Lat. 2 (10)*, cf. Galletier (1949)

114ff.). However, there is no evidence for their identification as one society (Drinkwater 2007: 122), and the time of ethnogenesis is generally difficult to establish. While some finds suggest they originated from the Elbe-Saale or elbgermanic area, no assemblage could really point to a specific area or a common ethnic origin, and there is no evidence for them having formed into a "tribal alliance" within the region of Germania before the migration period (Wenskus 1961 ; Pohl 2000: 30f.; Geuenich 2008: 503). Geuenich (2005: 15ff.) suggests that during the 3rd and 4th centuries, peoples formed of individual groups, coming from a variety of areas with cultural influences from the mid-Danubian region, the Carpathian Basin, as well as from Hunnic and Suebic peoples, and settled along the areas of the Rhine[9].

2.1.2 Temporal and environmental settings

While for the early periods before the 5th century, sites of individual small settlements (via the presence of cemetery evidence; cf. several papers in Fuchs 1997) as well as hillfort structures ("Höhensiedlungen", Steuer 1973 ; Steuer 1994 ; Quast 2006) are known from throughout the Alamannia, for the periods following the 5th century, when the Alamannia expanded towards todays Alsace region, Switzerland and Bavaria (Steuer 1973), very few Alamannic settlements are excavated (Willmy 2008), the largest and only complete one at Lauchheim (6th - 12th century, Stork 1997b). This is unfortunate considering the investigation of social structures, since the scale and nature of settlements would have had an

[9] These settling groups of people may be what the Romans would have considered 'sub-tribes' of a larger, territorial unit, which they summarized as "the Alamanni" (Drinkwater 2007: 123).

impact on the local levels of social significance of a community and their inhabitants (Hummer 1998b), and traceable settlement structures may provide evidence of concepts of households or familial relations (Damminger 1998). However, archaeological finds from the few sites uncovered provide us with some indications of Alamannic life, including building structures (e.g. Grubenhäuser, longhouses or farmsteads, Damminger 1998 ; Quast 2006) or occupations, trade and craftsmanship (e.g. textile, wood and iron working[10] (Steuer 1973 ; Banck - Burgess 1997 ; Wolf 1997)). Archaeobotanical and archaeozoological research, including biological remains found in burials, provide evidence for the Alamanni having been sedentary peasants who produced a great variety of food plants, including crops and garden produce (Rösch *et al.* 1992 ; Rösch 1997; 1998; 2008) and relied heavily on animal husbandry, including cow, pig, sheep and goat (Kokabi 1997 ; Stephan 2008). For any kind of agricultural activity, climate, soil quality and water resources are of major concern. Therefore, for the people who would form the Alamanni, the areas along Rhine and Neckar would have been highly covetable[11], as in general and geographically, life in the Alamannia would have meant a rural life (Willmy 2008), continuously relying on farming (Drinkwater 2007: 337f.). Settlements along the rivers and next to old Roman trade routes, such as Pleidelsheim (cf. Chapter 4.1.1), came with a higher degree of exposure to the potency of political rule, since these locations would be economically very attractive. Cemetery evidence of settlements such as Neresheim on the eastern Swabian Alb (cf. Chapter 4.1.2) show that the Alamanni proved equally successful in settling in

[10] As no archaeological evidence for mining could be found, and only some indications for iron mining are known (Szöke 1967), it is believed that the Alamanni mastered the reworking of metals obtained from imported materials as well as grave robbery (Steuer 1973).
[11] In late Antiquity, the region of the Alamannia is described as a good source for building timber and iron mining (Drinkwater 2007: 133).

less favourable areas which were higher situated and further away from areas economically interesting to the Merovingian rulers (Quast 2006).

At the start of the 6th century (after 506 AD, Hummer 1998b ; Drinkwater 2007: 344), people settling in the Alamannia (still a geographical and not geopolitical entity, Drinkwater 2007: 124), found themselves between two political powers, the Franks in the northwest[12], and the Ostrogothic king Theodoric (471 - 526 AD) who wanted to protect the independence of the southern parts of the Alamannia (Geuenich 2005: 86ff.; Drinkwater 2007: 337, 345). Only with the approach of the mid 6th century, at *c*. 537 AD (Ament 1980 ; Geuenich 2005: 92ff.), came the loss of Alamannic "freedom" and independence and the onset of the Frankish rule over the region. And it is only now that a territorial "unity" and identity as Alamanni is proposed (Geuenich 2008), as now "the Alamanni" can be defined as people settling[13] in the Frankish province of Alamannia, a region extending approximately 750km east to west and 650km north-west to south-east (cf. Geuenich 2005: 70f.; Drinkwater 2007: 332) that was entirely under Frankish direction with the advent of 7th century (Hummer 1998b). However, a complete integration of the Alamannia into the Merovingian kingdom is only historically secured for the period of subsequent Carolingian rule (8th century (Drinkwater 2007: 347)).

Interestingly, most of these descriptions of historical and socio-political events apply to the region to the left side (i.e. west) of the Rhine, while very little is known

[12] After reports by Gregory of Tours, Frankish troops conquered the Alamanni in 496 AD in the Battle of Zülpich (Tolbiacum) (Geuenich 2008).

[13] This includes the influx of a new Elbgermanic immigration (from the region of today's Bohemia), including Hunnic influences, during the early 5th century (Drinkwater 2007: 338; 343f.).

about Alamannic populations to the east (i.e. right side)[14] (e.g. Geuenich 2008)). The two cemetery sites under study, Pleidelsheim and Neresheim, are therefore especially interesting with regard to these socio-political changes, as not only did they both belong to settlements on the right side of the Rhine (cf. Chapter 4.1) and in differing distance to the centre of the Frankish empire, but they show continuous use and hence resident population from the 5th to the 7th century, covering the pre-Frankish and Frankish period. It is an ongoing matter of debate whether the Alamanni were entirely subjected to Frankish customs, or whether they continued to live largely independent of their official sovereign (Steuer 1973) with regard to their customs and lifeways - which in themselves are still largely unexplored and yet fundamental to any proposition about social complexity. Thus, it will be of interest whether any impact of these transformations or socio-political circumstances, any effects of continuity or change, can be traced in the evidence that the burials from these two local Alamannic populations provide. The history of the formation of the Alamanni means a distinct lack of biological and cultural units - the difficulties this poses to an archaeology that is trying to classify and form typologies is becoming evident with regard to the cemetery analysis.

[14] Indeed, statements about political and social organisation in that area are mostly conjecture, e.g. "[…] die Herrschaftstruktur [dürfte dort] weniger ausgeprägt gewesen sein als in den Gebieten am Ober- und Hochrhein […]"(Geuenich 2008: 18).

2.2 The archaeology of Alamannic cemeteries

2.2.1 Cemetery and burial structures

The vast body of evidence that provides insight on Alamannic life is through the wealth of cemeteries that remain of the settlements, as it is the case with Pleidelsheim and Neresheim. Cemetery evidence in the Alamannia for the early Merovingian period, i.e. the 4th and early 5th century, is scant, with only a small number of known individual burials, often isolated or in small groups, including cremations and inhumations (Quast 1997 ; Drinkwater 2007: 340). Only with the beginning of the 5th century, evidence of small settlement cemeteries appears (Quast 1997), indicating a sense of community in life and death. At around 450 AD, profound changes can be observed with regard to burial customs[15]: inhumations became the norm, as did cemeteries with burials oriented in west - east direction (i.e. the head pointed westwards). In the early phases, the order would still vary and be faintly broken up into what are assumed to be spatially grouped burials (Siegmund 2000: 97f.; Effros 2003: 196f.; Drinkwater 2007: 341), while from the 6th century onwards, a systematized style of row grave cemeteries prevails, which characterises Merovingian culture (Steuer 2004) and would lend its peoples the term “Reihengräberzivilisation” (“row grave civilisation”, James 1980 ; Halsall 1992 ; Steuer 2004 ; Fehr 2008). In these cemeteries, which would have often covered a timespan of around 250 years and contained an estimated 1000+ burials (Quast

[15] This phenomenon is not confined to the Alamannia but a widespread phenomenon in the change of burial customs; so-called ‘proto-Reihengräber’ are described for 4th century Northern Gaul (Halsall 1992), and a Germanic influence on their formation is still discussed (Böhme 1974 ; James 1980 ; Young 1980 ; Halsall 1992), alongside with opposing suggestions of a rather Roman context (Drinkwater 2007: 341).

1997 ; Schreg 2008), the deceased were buried in a variety of grave types, in unified orientation and supine position, dressed and usually endowed with a number of grave goods including jewellery, weaponry, tools, food and drink (James 1980 ; Stork 1997a ; Halsall 2003b: 51f.), and, at later stages, even horses (Oexle 1984). A differentiation according to groups, whether determined by burial wealth, grave good assemblages, age or sex of the individuals, is not recognisable in the row grave cemeteries from the 5th to 7th century (Schreg 2008). Furthermore, Alamannic row grave cemeteries would somewhat differ from Frankish ones in their economic and social homogeneity (Drinkwater 2007: 341), i.e. considering a less strictly regimented dispersion of burial types and grave goods among and within the cemeteries. Steuer (2004) interprets the phenomenon of row grave cemeteries and the style of burial they reveal as a general symptom of a society in which the self-portrayal and cultivation of an image was fundamental for families and individuals in order to demonstrate and manifest their status[16]. Only by the end of the Merovingian period, towards the late 7th century, some Alamannic cemeteries show evidence of separate burial groups (e.g. Kirchheim / Ries, Neuffer-Müller 1983), indicating a change in societal representation of status by burying high-ranking individuals, measured archaeologically by the burial wealth, detached from the other inhabitants of a settlement (so-called élite burials, Stein 1967 ; Theune - Großkopf 1997 ; Ausenda 1998 ; Burzler 2000 ; Steuer 2004), however, neither Pleidelsheim nor Neresheim reveal such structures (Knaut 1993 ; Koch 2001).

[16] Steuer maintains that the burial would be the last time that a person's rank could be expressed by material wealth (Steuer 2004: 195).

However, the variety of burial types occurring in Alamannic cemeteries can be exemplified at both sites. Except for tumuli graves, which are comparatively rare in Alamannic cemeteries but, if present, archaeologically recognisable by a ditch or their isolated location within the cemetery (e.g. at Fridingen, von Schnurbein 1987 ; Stork 1997a), rather small in diameter and usually associated with high status individuals (Schreg 2008), Pleidelsheim revealed almost all grave type varieties that are known for the period under consideration and region[17]. As Table 2.1 shows, this includes burial pits of varying width and depth, with the deceased potentially placed in a simple wooden coffin; coffin burials with remaining space for placing grave accoutrements (usually placed to the left hand side, Stork 1997a); burial chambers, some of which showing trans-regional influences (e.g. type "Morken"[18]), and where the deceased was laid on a "bed" or in a normal coffin, the grave chamber potentially being so large that the deceased would only occupy a third of the chamber; double burials, which could show all combinations of age and sex, as well as occur as various types of burial (Lüdemann 1994). Koch (2001) was able to divide those grave types, many of which would occur contemporaneously, into 14 categories (Table 2.1), however, due to the lack of preservation of wooden structures at this site, they must be considered with caution. A general classification into "simple" burials in relatively narrow burial pits, coffin burials in shafts with sufficient space for the placement of grave goods, and burial chambers (with a width of more than 100cm, Martin 1976) seems more appropriate.

[17] Although burial 247 at Pleidelsheim may have been marked by a small mound, suggested by its location in the cemetery (Koch 1997a).
[18] Grave chambers type "Morken" have been frequently found in the upper Rhine area, Hesse, Westphalia, north Belgium as well as Saxony and Thuringia, areas which, to their northern part, were in contact with Germanic populations (Knaut 1993: 27).

Table 2.1: Grave types at the cemetery of Pleidelsheim, after Koch 2001

Type	***Description***	***Possible features***	***Body position***	***Period [a)]***
1	extremely narrow burial pit (shaft grave), W-O aligned	**1a**: wooden coffin, possibly tree trunk **1b**: wider construction	supine; upper limbs beside body or placed on it	AM, beginning mid 5^{th} c. AD
2	simple shaft grave	wooden coffin, possibly tree trunk	**2a**: supine; arms beside body or placed on it **2b**: wider construction	AM to JM, with change from tree trunk coffin to wooden coffin
3	simple narrow, deep grave	wooden coffin	supine	AM to JM
4	burial pit with body / coffin near south wall	wooden coffin	supine; upper limbs beside body or placed on it	not very common form of burial, but AM to JM
5	coffin burial near north wall of long rectangular, deep pits	wooden coffin	supine	AM to JM
6	coffin burial near north wall of long rectangular, shallow pits	wooden coffin	supine; a little constricted	AM to JM
7	spacious burial pits, shallow depth	wooden coffin / structure	supine; upper limbs beside body or placed on it; a little constricted, or wider construction	mainly 6^{th} c. AD
8	burial chamber, with coffin placed centrally	wooden coffin in wooden chamber	supine	from mid 6^{th} c. AD
9	coffin burial near north wall of broad burial pits	wooden coffin	supine	from mid 6^{th} c. AD
10, 9/10	burial chamber, with burial near north wall (type 'Morken', Frankish)	wooden coffin or 'bed' in wooden chamber	supine	mainly towards end 6^{th} c. – mid 7^{th} c. AD
11	narrow burial chamber	no coffin; wooden chamber	supine	6^{th} c. AD, probably Thuringian influence
12	large burial chambers, with body in north-westerly corner	wooden chamber	supine	AM to JM
13	large burial pits, with free space at foot end	wooden chamber?	supine	not a common form of burial; AM to JM
14	double grave	larger burial pit or burial chamber	supine and next to each other; adult – adult or adult – child	AM to JM, with increase in first half of 7^{th} c. AD

[a)] for chronological reference, cf. Table 2.2; in many cases, it was not possible to establish the exact nature of the burial container due to preservational reasons present in the cemetery.

At Neresheim, roughly the same variety of grave types could be recorded, however, with seemingly much lower variation among the individual types (Knaut 1993). The excavation report for Neresheim lists evidence for 22 tree trunk coffins (Knaut 1993), which Koch (2001) assumes among the Pleidelsheim grave types 1 (cf. Table 2.1) and which were a common and widespread burial custom during the earlier Merovingian period (Knaut 1993: 26; Stork 1997a); preserved examples were recovered from Oberflacht (Schiek 1992). Grave chambers are present at this site as well, however, smaller in their dimensions than at Pleidelsheim, mostly with the body found centrally in the chamber, and none of the type “Morken” (Knaut 1993: 27).

Considering the diversity of grave types at cemeteries such as Pleidelsheim and Neresheim, as well as the tradition of archaeological research on Merovingian populations, it is not surprising that this variety and apparent scale from very simple to very elaborate burial types would inevitably lead to a direct association of grave types with status (i.e. grave chambers of the élite, simple, narrow coffins of the servants, Martin 1976: 12ff.).

2.2.2 Phasing

For the early medieval period, there are only very few cases in which dendrochronology or radiocarbon dating was applied for scientific dating (Christlein 1991: 18), and there exist only a few precisely dated burial inventories (e.g. Childerich, 481 AD (Knüsel 2006); Raedewald, Sutton Hoo, 624/25 AD (Carver 1992)) from which objects can be correlated with historical events. Considering the wealth of burial evidence from Alamannic and Merovingian cemeteries, chronological considerations and attempts to rank the burials on Alamannic cemeteries by period started relatively early with seminal studies by, for instance, J. Werner (1935) and K. Böhner (1958)[19], who expanded on Veeck's (1931) categorisation into an early (i.e. before the Frankish expansion) and late phase (covering the Frankish rule up to the Carolingian period; cf. Table 2.2). They created a system of chronological phases for Alamannic cemeteries which did not differ greatly from each other, starting during the second half of the 5th century, defining a new phase with the onset of the Frankish rule and continuing up to the Carolingian period (Böhner 1958; Table 2.2). F. Stein (1967) extended those phases from the late 7th to the mid-8th century through his studies of Alamannic "élite burials", i.e. late Merovingian separate burial groups (Table 2.2). While R. Christlein (1966) expanded on these periodisations and devised a supra-regional and frequently used system for dating male burials of the Merovingian period on the right side of the Rhine (i.e. using weapon and, primarily, belt buckle typologies), U. Koch (1977) developed a similar, yet independent system using the materials found at the Alamannic cemetery of Schretzheim, focussing on the female burials (i.e. grave goods, especially fibulae and beads) and devising a chronological reference system consisting of six periods which, however, only start with the time around the year 525 AD and extend into the 7th century (Table 2.2). H. Ament (1977) presented a slightly different phasing at the same time as Koch, dividing the burials into older (AM, 400 - 600 AD, Table 2.2) and younger (JM, 600 - 720 AD, Table 2.2) Merovingian periods with three sub-

[19] Werner (1935) started with the dating of burials based on numismatic evidence, on which he based his periods I - V (cf. Table 2.2; cf. also Steuer 1977 ; Koch 2001: 26ff.), and which he later elaborated on by studying male belt buckle variations, using material from the Alamannic cemeteries at Bülach and Mindelheim (cf. Kokkotidis 1995). Böhner (1958) created a typology for material evidence from a confined area and connected his groups with coin-dated evidence from around this area, establishing five periods for the chronological periodisation of Alamannic cemeteries which are considered to have supra-regional validity (Ament 1977 ; cf. Kokkotidis 1995).

phases for each and offering a more standardised reference system for the southern regions of the Alamannia. Koch largely followed his categorisation, and her periodisation is currently considered to be the general basis for attributing burials to phases in Alamannic history in southwest Germany (Koch 1977; 1982), culminating in the development of relatively narrow "SD-phases" for the cemetery of Pleidelsheim (Koch 2001; Table 2.2), established by creating typologies of the grave goods found in male and female burials and relating them to finds from other cemeteries in the Alamannia (Koch 2001: 353).

Table 2.2: Relative chronology of Alamannic cemeteries. Modified after Knaut 1993: 189, with additional data from Veeck 1931, Werner 1935, Knaut 1993, Koch 2001

AD	*fixed dates*	Veeck (1931)	Werner (1935)	Böhner area of Trier (1958)	Stein élite burials (1967)	Ament merov. periods (1977)	Koch Schretzheim (1977)	Koch Bargen Berghausen (1982)	Knaut Neresheim (1993)	Koch Pleidelsheim (2001)
400		**early phase** → until Frankish expansion (536 AD)							**Phase 1** 1st half 5th c.	**SD-Phase 1** until ca. 460
450	Childerich I. 457 - 481/82		**Phase I** 450 – 520	**Phase I + II** 450 - 525		**AM I (A)** 450/80 - 520/30			**Phase 2** ca. 450 - 480/85+	**SD-Phase 2** 460 - 480
	Chlodwig I. 482 - 511									**SD-Phase 3** 480 - 510
500	**Frankish rule**								**Phase 3a** ca. 500 - 525/35	**SD-Phase 4** 510 - 530
		late phase → until Carolingian Empire	**Phase II** 520 - 550	**Phase III** 525 - 600		**AM II (B)** 520/30 - 560/70	**Phase I** 525 - 545/50		**Phase 3b** 525/35 - 545/50	**SD-Phase 5** 530 - 555
550			**Phase III** 550 - 600				**Phase II** 545 - 565/70		**Phase 3c** 545/50 - 565/70	**SD-Phase 6** 555 - 580
						AM III (B) 560/70 - 700	**Phase III** 565 - 590/600	**Phase 1** 590 - 620	**Phase 3d** 565/70 - 590/600	**SD-Phase 7** 580 - 600
600			**Phase IV** 600 -650	**Phase IV** 7th c.		**JM I (C)** 600 - 630/40	**Phase IV** 590 - 620/30		**Phase 4a** 590/600 - 620/30	**SD-Phase 8** 600 - 620
						JM II (C) 630/40 - 670/80	**Phase V** 620 - 650/60	**Phase 2** 620 - 650	**Phase 4b** 620/30 - 650/60	**SD-Phase 9** 620 - 650
650			**Phase V** 650 -700			**JM III (D)** 670/80 - 720	**Phase VI** 660 - 680	**Phase 3** 650 - 670/80	**Phase 4c** 650/60 - 680	**SD-Phase 10** 650 - 670
					Phase A 680 - 710/20 AD			**Phase 4A** 670 /80 - 710	**Phase 4d** 680 - 700	
700	Carolingian Empire			**Phase V** 8th c.	**Phase B** 710/20 - 750 AD			**Phase 4B** 710 onwards		
750	'Canstatt'									

The chronology established for Neresheim (Knaut 1993) falls between the proposed periodisations (Table 2.2), as a high degree of disturbance of the burials required a heavy dependency on the consultation of material evidence from neighbouring cemeteries, such as Schretzheim, which show a similar development to this cemetery and would provide comparable evidence to the material remains (Knaut

1993: 187ff.). Thus, the importance of external periodisation is exemplified here. Given the individual periodisation presented for every cemetery studied (Christlein 1991: 14ff.) and a framework that relies entirely on the typological categorisation of grave goods without verification by scientific dating, the present state of research on any given object type of material evidence, and overall only relative chronologies, it becomes clear how difficult and problematic a chronological placement of burials is within an Alamannic cemetery[20]. Given that the youngest artefact in a burial is the reference point for dating the burial, it is technically the acquisition of the object, whether weaponry or dress component, that is dated (Brather 2004b: 6), and in many cases, especially in female burials, there is evidence for the presence of either handed down pieces or their re-working of objects into others (e. g. Quast 2006). However, the advantages of a relative chronology (Ament 1977 ; Christlein 1991) are acknowledged by most researchers (e. g. Siegmund 2000: 78f.), as most Alamannic cemeteries are either not fully excavated, preventing a local chronology, or the archaeologists are faced with the problem of extensive grave robbery[21]. It is likely that this was not a phenomenon that occurred only centuries after the burial, but possibly already a relatively short time after the body was laid to rest (Thiedmann and Schleifring 1992). Eighth-century law codes[22] illustrate a heavy punishment for grave robbers (Stork 1997a), and marks on the skeletal remains commonly show indicators for probing the burials with a rod in order to detect the position of the body and valuable grave goods, i.e. a certain knowledge about the burial type and accoutrement may have been provided.

[20] For a more detailed account regarding the problem of a different state of research in different regions, see Stork (1988: 339ff.).
[21] For a detailed study on this phenomenon, see Kümmel (2009).
[22] *Lex Alamannorum* 57.9

The devised chronological systems allow for an at least approximate dating of the burials, albeit the almost indispensable condition of the presence of (classifiable) grave goods. Yet, despite the attempts of the proposed models of cemetery chronologies to trace changes in burial evidence that are congruent with the socio-political changes at the time (cf. Table 2.2), a realistic reflection of the latter in the burials is generally unlikely, as the burial process presents a funerary rite bestowing a multitude of meanings onto the material evidence. A reflection of family groups (e.g. Jørgensen *et al.* 1997) and therefore spatially interrelated burial structures by establishing contemporaneity is virtually impossible, as it is uncertain how many graves remained undiscovered or were destroyed by modern interventions often only leading to the discovery of the site.

2.3 Social complexity in early medieval Alamannia

2.3.1 "Status of the living and status of the dead" - Common assumptions

Law Codes

The most fundamental sources used alike by historians and archaeologists to find correlates for Alamannic social structure are Merovingian legal codices issued in the early medieval period, among them the *Leges Francorum* and the *Leges Alamannorum* (Table 2.3).

Table 2.3: Law codes relevant in this study, after Roth (2003)

	Codex	***population***	***date***
Leges Francorum	*Lex Salica*	Salian Franks	between 507 - 511 AD
	Lex Ribuaria	Ribuarian Franks	763 / 764 AD
Leges Alamannorum	*Pactus Alamannorum*	Alamanni	*c.* 600 AD
	Lex Alamannorum	Alamanni	between 712 - 725 AD

Those 'Barbarian laws' are to be primarily understood as instructions[23] to re-establish social peace (von Olberg 1991: 18), by mainly outlining the compensations (*wergild*) that had to be paid in case of sustained loss or harm by the guilty party to the victim(s) or their dependents. They present codes for penitence and judgments about monetary fines[24], and are permuted to a reflection of life by inferring legal status from monetary value, despite often raised critique as to their actual implementation in life and practice (Murray 2000 ; Halsall 2005: 533). Moreover, it is not clear whether they reflect socio-political practices already in use, or whether they imposed pre-ordained practices on the people (Theuws 2009: 291). Altogether, it is not without concern that the reconstruction of social complexity, functioning and, ultimately, identities is based on textual sources that are highly debated with regard to their judicial character[25] and dates of origin (due to the existence of different scripts, a large gap between the assumed date of creation and the translated texts, and several provisions (von Olberg 1991: 19; Kroeschell 2008: 31ff.).

The Frankish laws, *Lex Salica* (late 6th century, Murray 2000: 533) and *Lex Ribuaria* (7th century (Wormald 2003); Table 2.3), heavily influenced by Roman legal sources, are used by scholars for reconstructing Alamannic social organisation (e. g. Brather

[23] "Its fame is of course a reflection of the importance of the Franks themselves and their influence on European institutions." (Murray 2000: 533)

[24] *Pactus* and *Lex* also include laws on *wergild* sums in life in general, such as the morning gift; codices about bodily harm include relatively exact descriptions of anatomical parts of the body as well as differentiations of the extension of harm done, e.g. the consequences of a box on the ears, or whether a foot is cut off and the person can still move around with the aid of a crutch or not (PA 11 § 3; cf. Schmidt - Wiegand 1978).

[25] "What is accessible to historians […] is not the self-assured working of a community but rather its inner and outer tensions." (Pohl 2003)

2008b)[26], despite the presence of the *Pactus Alamannorum*, only conveyed in fragments (Kroeschell 2008: 31f.) and possibly dating to the turn of the 6th / 7th century, and the *Lex Alamannorum* (8th century, Steuer 1997). While the *Pactus* compiles law codes for elements of offence and their compensations (Schott 1978b), the *Leges* present a more substantial compilation and include Alamannic common law as well as entries regarding ecclesiastic and 'dukedom' laws (Schneider 2001: 28; 93ff.). Not only does this reflect the problem of pertinence, the Frankish dominance of power structures and desire for authority (Halsall 2003b: 52), but their terms, all franco - latin composites (Schmidt - Wiegand 1978), indicate a socially stratified society including large farmsteads and individuals such as servants and maidservants (Schneider 2001: 93ff.).

The construction of a status hierarchy is deduced from the *Pactus Alamannorum*, with associated *wergild* sums (Schott 1974) and equivalent appellations in the *Lex Alamannorum* (in brackets; Steuer 1973: 157):

I. *ingenuus* (= free)
    i. primus; meliorissimus [optimatus] (= ruling stratum) - 240 solidi
    ii. medianus [medius] - 200 solidi
    iii. minofletus [minoflidis] - 160 solidi
II. litus [ingenuus Alamannus; colonus] (= dependants)
III. servus [letus, mancipium] (= slaves)

Hence, the laws imply a society that was, quite independently of gender, ranked. Interestingly, and omitted by archaeologists, the *Pactus (14.9 - 11)* does list the above terms also for women (i.e. *ingenua, femina minoflidis, femina mediana,*

[26] This is being done for no obvious reason other than the lack of tangible information from the Alamannic law codes (Halsall, in discussion to Siegmund (1998a: 211)).

femina prima Alamanna (Schott 1978b; 1993)), unlike the *Lex Salica* (Schmidt - Wiegand 1978), which is equally used for the Alamanni and would therefore mean a failure to detect a potential differential position of women in Alamannic societies, as opposed to Frankish ones.

The only principle that can be assumed with some degree of certainty is that of a distinction between ‘free’ and ‘unfree’ in the Alamannic law codes. Only the free had full status as a person according to the laws, which means that all we conclude on the living society from the laws is about the ranks of the free. This entails that especially about the lower levels of society, we know absolutely nothing, as they also left no grave goods or only very small ‘insignificant’ quantities. The significance of the middling element of “*litus*” is not clear (Schott 1978a), nor are any mechanisms that would have facilitated a transition from one rank to another, as in order to free someone, a structure determined by, for instance, the military or the church would be the norm (Schott 1978a ; Weidemann 1982: 299). A further limitation emerges with a closer look at the contents of the law codes, which reveals that the descriptions of compensation sums, from which archaeologists determine the “value” and wealth of people that is eventually expressed in their burial, are mostly describing individuals belonging to the “free” group.

Hartung (1983: 119ff.) rightly points out that the law codes were an instrument of government control, as authority - the Franks - can only rule over something - the Alamanni - that is manifest (the principle of "Herrschaftstechnologie", Hartung 1983: 120). Therefore, the laws present the attempt to categorise Alamannic society by determining and imposing a status hierarchy on them, aligned with the

Frankish order[27], which may or may not have resembled existing structures of Alamannic social organisation. It is questionable how long it took for the codices to be installed in all areas of the kingdom and how great their impact was in more remote areas, such as parts of the *Alamannia*. Hence, all models for Alamannic social structure are based on a constructed system of status hierarchy that derives from highly debated written sources as well as from ideas of social functioning deeply anchored in 19th century tradition, including all aspects of social identity and roles. A societal structure as described in the law codes is by no means demonstrable in the archaeological evidence (Hartung 1983: 121). Steuer (1973) opines that not the Frankish legal statuses would be traceable in the row grave cemeteries, and wealthily endowed graves could not be equated with "élite" burials ("Adelsgräber"), but rather, that a general distinction between a socially leading level[28], a middling level of peasants, and a low stratum of dependants could be discerned.

Grave furnishings

> *"Social analysis has not, in the past, been particularly scientific [...], consisting mainly of attempts to fit different burial characteristics into the various social groupings distinguished by the Germanic law codes, as if legally defined groups actually do necessarily correspond to social groups, or as if either would necessarily be reflected clearly in a cemetery layout or in the choice of grave goods. The crude attempts which correlated the presence of certain weapon-types with different legally defined classes […] have been abandoned, but we still await for a more*

[27] "A law somehow emerges from the society to which it applies, helping not just to resolve its tensions but also to demarcate it as a community." (Wormald 2003: 22)

[28] "[…] die immer am einfachsten in den Bestattungen zu erkennen ist […]", Steuer 1973: 157.

informed analysis." (James 1980: 40)

This statement by E. James is, unfortunately, still true 30 years later and indicative of the inherent difficulties of most hitherto existing research on Alamannic social structure. The earliest classification of grave goods based on a correlation of textual sources (the Alamannic laws) and weaponry in Alamannic graves was proposed by Veeck in 1926, reflecting the quality and, first and foremost, quantity of armament in a grave onto the social status of the individual interred, an approach that did not lose its dominant role for the next decades (cf., for instance, Martin 2002)[29], despite some criticism since the 1970s which, regrettably, did not entail appropriate suggestions for new directions. The proposition by R. Christlein (1973; 1991: 83ff.) to classify Alamannic grave goods into 'quality groups' ("*Qualitätsgruppen*") is still the predominantly used approach to interpret cemetery material culture, especially with regard to high-status graves and the question of élites, although several authors pointed out the obsolescence of this method (e.g. Samson 1987 ; Härke 1990 ; Halsall 2005). Christlein counted and evaluated all grave goods and classified the row graves as follows (Table 2.4): 'quality group' A (poor or without any grave goods included), B (rich free people with authority at the local level), C (exceptionally rich free people with more than merely local control), and D (*reguli* or *duces*, i.e. leading figures within a society).

[29] Despite rejecting the comparison with textual sources, he explains: "Dank der Tatsache, dass der Fundstoff dieser Epoche […] sich fast ausschliesslich aus einer Unzahl geschlossener Funde zusammensetzt, die gewissermassen *ad personam* fixiert sind, ergeben sich Möglichkeiten, weibliche wie auch männliche Grabinventare anhand ihres Wertes jeweils miteinander zu vergleichen. Nicht mehr die Waffen der Männergräber werden - einseitig - mit Schriftquellen in Verbindung gebracht, in denen sie gar nicht angeführt sind (!), sondern es wird der Wert aller auswertbaren Grabinventare messbar gemacht." (Martin 2002: 298).

Table 2.4: Classification of grave goods into "quality groups" ('QG'), after Christlein (1973) and Steuer (1989) (translation by the author)

'QG'	*burial equipment*	*male burial: examples of grave good combinations*	*female burial: examples of grave good combinations*	*classification*
A	without grave goods / hardly any grave goods	seax, bow & arrow, undecorated belt	glass beads, knife	(very) poor
B	some grave goods	sword, seax, spear, shield, decorated belt, glass vessel (6th c.)	brooch, hairpin, earring, necklace, amulet, girdle hanger, calf decoration, shoe buckles, silver finger ring, glass vessel (6th c.)	average or average wealthy
C	(more elaborate) grave goods	sword, seax, shield, *ango*, decorated belt, horse equipment, bronze vessels, bronze-furnished bucket, glass vessel (7th c.)	brooch ensemble, hairpin, earring (silver / gold), necklace, girdle ensemble, calf decoration, shoe buckles, golden finger ring, bronze vessel, furnished wooden casket, glass vessel (7th c.)	rich, above-average wealth
D	as C, but much more elaborate and specially manufactured items			exceptionally wealthy

Not only are objects placed into fixed gendered categories on the basis of modern assumptions on their affiliation with either males or females, but a validity is attributed to them which is entirely subjective and based on broad quantity- and quality-related comparisons that correspond with the law codes, even though Christlein refused to equate grave good categories with named statuses from the written sources, as he wanted to demonstrate social gradations by differences in burial wealth alone. Table 2.5 shows typical Alamannic grave good inventories of the 6th and 7th century, according to males and females, and their suggested spectrum for 'quality groups' A to C (group D equals so-called "princely" burials such as found in Morken (Böhner 1959), Krefeld-Gellep (Pirling 1964), or the grave of Childerich in Tournai, and is not included in this list). Christlein argues that the grave goods mirror the economic power of a family, a model that does not, in fact, assign one quality group to a specific social stratum or class, as he himself did not distinctly suggest a certain social stratification system, but which relates the quality and composition of a grave good assemblage to the habitus of people of a certain rank (Christlein 1991: 83ff.).

Table 2.5: Grave goods and their 'quality group' attributions, after Christlein 1973 (translation by the author)

Male grave goods	**'QG'**	**Not gendered (both)**	**'QG'**	**Female grave goods**	**'QG'**
bow & arrow	A	glass vessel (7th c.)	B, **C**	gold beads	C
seax	A, B, C	bronze vessel	C	knife with gold handle	C
glass vessel (6th c.)	A, B, C	bucket with bronze fittings	C	gold disc fibula	C
lance	A, **B, C**	gold ring	C	silver calf decoration	C
spatha (=sword)	B, C			wooden casket with bone- or metal fittings	B, **C**
shield	B, **C**			golden earrings	B, **C**
spur	B, **C**			silver ring	B, **C**
wooden bucket	B, **C**			bow fibula	B, **C**
ango (=spear)	B, **C**			silver earrings	B, **C**
helmet / armour	C			ornamental needle	B, **C**
snaffle & harness	C			ornamental disc	B, **C**
				calf decoration (iron/bronze/metal sheet)	B, C
				disc fibula (silver/bonze/iron)	**B**, C
				bronze earrings	**B**, C
				glass beads	A, **B, C**

'QG' = 'quality group'; A = poor, B = average or average wealth, C = rich, above-average wealth; bold letters indicate object occurring mostly in a certain 'quality group'

Thus, objects that combine all three 'quality groups' could be in possession of the poorest and the richest of members of society; in some cases, only their elaboration (i.e. material or ornamentation) would distinguish the objects from each other, a detailed list of which including their classifications and characteristics as grave goods can be found in App. 2, Table 1. The limitations of Christlein's approach, acknowledged in the meantime yet not abandoned (e.g. Siegmund 2000: 79), are manifold: he premises uniform burial practices over a timespan from 500 to 750 A.D. as well in an extensive geographic area, and, in addition to that, consistent behavioural patterns through time and space of a society made up of different groups (Steuer 1989). More importantly, he does not take into account the ritual context and the motives of the group that conducted the burial and placed the objects into the grave, but solely the qualitative character of the objects themselves (Samson 1987; cf. App. 2, Table 1). Thus, the objects are used to create hierarchies of the dead, and potential changes in their meanings overlooked; in principle, this method creates a social order of the burials, not of the living people who made these material goods, used them, buried them and were buried with them.

The starting point for analysing Alamannic cemeteries is still that differences in armament (males) or jewellery (females) echo differences in social status of the individuals (e.g. Pusch and Czarnetzki 2003)[30] and their families, despite the acknowledgement that the archaeological data presented in a burial are the end-products of a complex filtering process (e.g. Jørgensen *et al.* 1997), therefore not mirroring social reality (Härke 1994 ; Parker Pearson 2001). Many ethnographic studies defy the assumption that there are simple correlations between components such as wealth of grave goods and wealth of the deceased and their social environment, or features such as tomb size and status of the dead and / or the bereaved (Chapman 1987: 203). Analogies such as those formulated by Christlein cannot persist with any validity, seeing as they give way to theories of cemetery stratifications including family ranks such as those suggested by Koch (2001) for the cemetery of Pleidelsheim, who suggested the existence of "riders", "office holders" and their families, and "peasants" to supply them, or deducing a

[30] These authors, in 2003, still and unreservedly take up out-dated suggestions such as the number of arms indicating the social status of men, ranking them from rich (heavily armed), middling and poor (unarmed) (Huber 1967).

traditional and malapropos “class” system with cemetery stratifications as can be observed in the case of Kirchheim a. R., which features a late 7th century separate “élite burial ground” (Neuffer-Müller 1983). Even worse, it can prevent an interpretation close to all facts of burial context regarding small homestead cemeteries such as Niederstotzingen (Paulsen 1967), where the presumption of a ‘warrior class’ due to lavishly furnished weapon burials led to a complete misinterpretation of a group of individuals[31].

An equation such as “weapons = warrior” exemplifies the inherent problem of most archaeological interpretations for Alamannic cemeteries. Steuer (1982a: 312ff.) describes the ‘traditional’ division of Merovingian burials on the basis of above assumptions: élite burials (nobility), a bulk of well furnished and endowed graves (e.g. men’s graves with complete armament, in part in connection with horse burial, women with precious jewellery), ‘free’ men with weaponry, mainly with lance and buckler, ‘half-free’ and ‘unfree’ men, with bow and arrow and / or seax. Interestingly, silver arrowheads in late Roman graves are usually attributed to higher status; in the Merovingian period, however, they should represent the lower ranks of society. Steuer (1982a: 313) mentions that some weapon types, such as lance and bow, are preferentially found in the graves of younger men, an aspect that could hold a clue for a correlation of armament and age, however only in the context of a much broader mortuary analysis.

This points to a key concept that has to be taken into account - to look beyond grave goods in isolation. It is the nature of grave good data that we are presented with a set of intentional, selected and partial information (Härke 1997d).

[31] i.e. that of a warrior and his (male) followers, applied to a triple burial of three individuals, whose biological sex is ambiguous (Gut 2010).

Considering this, we have to ask all that Christlein did not: what does a burial reflect, for instance, private grief or the exigencies of public ritual? What role has the element of inheritance in society in influencing the grave good display? Could we, with regard to both the comparatively high amount of grave robbery in Alamannic cemeteries and the endeavour to study all levels of society, rely on the observation of gradations in less precious items? Did the furnishing with grave goods largely depend on how much stress an individual's death caused within a community, instead of primarily reflecting social status (Halsall 1996)? All conclusions we draw from the burial rite are subject to a multitude of intrinsic and extrinsic factors.

While grave good patterns are influenced by a variety of factors and do not 'mirror' social identity (in fact, in many cases distorting social reality, Hodder 1980), the skeletal evidence offers an undisturbed picture of the individual itself. While the burial data are part of a ritual, the skeleton itself is not and thus offers the possibility to contrast intentional (= burial) data with functional (= skeletal) data (Härke 1997d). Contrary to traditional Alamannic archaeology, this bioarchaeological study moves forward in contextual archaeology: all data, but especially the individuals themselves, are considered. Opposing the analytic and interpretational approach of starting social analysis at the uppermost social stratum (Härke 2000), this involves an unbiased study of the breadth of society, allowing for looking beyond the 'projected persona' in a burial and placing the individuals in a social context.

2.3.2 Premises on Alamannic social structure

Despite Christlein's affirmation that his approach to explore the reflection of actual social relations in grave furnishings does not have to concur with "institutionalised legal structures of early medieval society" (Christlein 1973: 148), archaeologists take as a point of departure in their studies a combination of grave goods and law codes to conclude on social structure. It suits the inductive Continental archaeological approach of moving from specific observations, for instance, from object typologies and their combination, to broader generalizations and theories, such as the "verification" of pieces of information from textual sources.

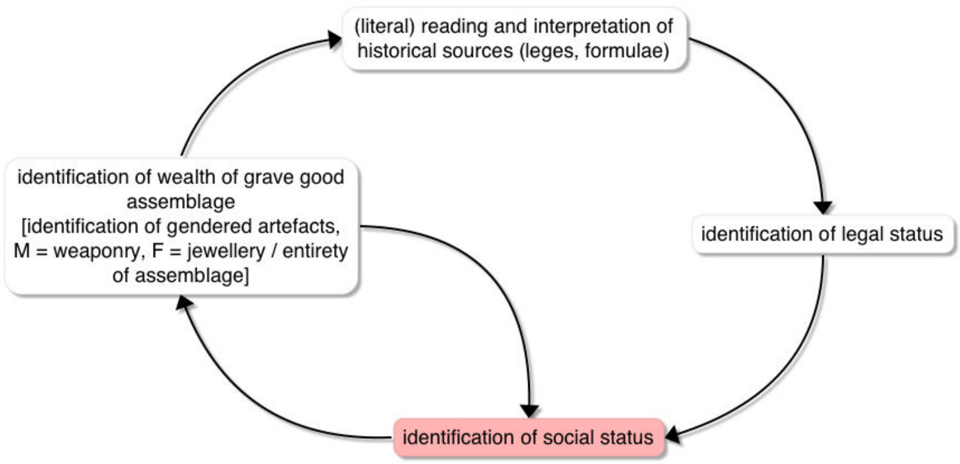


Fig. 2.1: Circular argument in traditional approaches to define Alamannic social structure

Fig. 2.1 shows the underlying principle and inherent circular argument of socio-historical and archaeological investigation of social structures for the Alamanni. It is hereby not relevant whether a direct association of grave good assemblage (the 'wealth' of objects or their composition) with social status is refused (Christlein 1973), or a higher complexity of social statuses based on several factors (family structures, 'profession', etc.) is presumed. However complex the implications of social constituents, it is implied that there is a correlation between the status of the living and equipment of the dead, with a 'shortcut' for archaeologists who accept the identifications of social statuses established by historians.

The only remote contact point with social identities, i.e. the component of sex and gender, occurs in the assessment of the grave good assemblage; but it is a gendering of artefacts and a classification of the objects that is projected onto the people, similar in nature to the process observable in Christlein's proposition. Furthermore, it is generally assumed that female status would follow the model valid for males (e.g. Steuer 1997), without consideration of potentially independent female status. Steuer (2004) rightly argues against the attempts to explore social reality by combining archaeological and textual sources and making them "fit" each other, as he questions whether these different sources could not give us indications for very different levels of Alamannic life; rather than social or legal *function* of the deceased, it is his lifestyle that is reflected in the burial (Steuer 1989).

Definitions of terms relating to social complexity

Before moving on to an outline of the current state of research regarding social structure and complexity for the early medieval Alamanni, it is advantageous to define certain relations and terms that are being used in the progress of this study.

- status and social standing:

Status, deriving from Latin *statum*[32], is used here in its widest sense as describing the standing of an individual in a social environment, based upon mutually accepted

[32] past participle of the verb *stare = to stand*

norms and in relation to other individuals (Halsall 1995: 22). Any equation of ‘status’ with ‘rank’, as often the case in historical and archaeological studies, is misleading (Halsall 1995: 22), as status comprises a broader meaning, i.e. one’s position within a social environment, and can even more comprehensively refer “to one’s value and importance in the eyes of the world” (Botton 2005: 3).

- rank:

Rank defines the position of an individual or group in a continuously vertical gradation of society. An individual can move between various ranks, assigning fluent passages and a high mobility level to a ranked society (Steuer 1982a: 22f.). We might encounter a whole series of statuses, graded relatively, in a society, instead of several social classes (Drucker 1939). In the case of a non-continuous rank order, the term ‘steps’ is preferred to ‘rank’ (Steuer 1982a: 23).

- stratum:

Contrary to ranks, societal strata are defined by clear borders between them, confining them in opposition to one another. Passing from one stratum to another would involve the acquisition of additional definable characteristics (Steuer 1982a: 23).

- class:

Although not being deemed an appropriate concept for pre- 19th century societies by the author, this term is listed here as defining a structural relationship within society (Saunders 2000: 210f.) as it appears in the historical suggestions for

Alamannic social structure: *strata* become classes if the vertical gradation within a society leads to direct dependencies (Steuer 1982a: 24), i.e. if one stratum becomes subordinate to another (e.g. free peasants to the élite). Certain characteristics, emanating from personal endeavour, still allow the passage from one class to another. The distinction of 'hierarchical class' from other forms of classes, formed through other dimensions of social organization (i.e. for instance the 'class' of craftsmen) is necessary (Halsall 1995: 23).

- familia and household:

The Roman concept of '*familia*', which is transferred onto Alamannic society in order to comprehend family relationships in cemeteries, describes not only the core family ("Kernfamilie"), i.e. father, mother and children, possibly also grandparents and siblings, this being the basic element of Germanic social structure (Steuer 1982a: 36), but also includes all members of a household, i.e. an economic unit (Steuer 1982a: 37) or extended family. The idea of the latter is not distinctly supported by Alamannic law codes; however, similarities can be found in inheritance paragraphs in the Lombard laws (Jørgensen *et al.* 1997). Thus, the term '*familia*' will be used in this study in correlation with Alamannic cemetery studies when a household is included, a family group ("Verband"), while however the term 'family' will be applied in cases were direct kinship relations may be described.

- group:

A group is seen as a definable sum of people from a population who share one or several common characteristics (Steuer 1982a: 22). Considering the investigation of social structures from burial evidence, a differentiation should be made between 'burial group', i.e. those burying their dead in a single cemetery, and 'social group', i.e. individuals living within a group of people such as a household, family, or settlement (Theuws 2009). Different groups can coexist as well as be hierarchised in a scale of societal values, i.e. regarding the value to other community members (Halsall 1995: 23). The transfer from one group to another is relatively easy.

Proposed model and current premises on Alamannic social structure

Our knowledge of Alamannic social structure is a composition of accumulated descriptions in the law codes and a correlation of material evidence. Despite his reservations (complex social structures are being neglected by the categorisation of grave goods, Steuer 1982a: 315ff.), Steuer presents the only proposition that is currently considered as generally valid for the development of a social model for the Alamanni by suggesting that it is worthwhile to look at nearby population structures, both chronologically and regionally, i.e. Germanic and Roman, Merovingian, Burgundian or Frankish. It is hypothesized that there are some general patterns present for the functioning of complex societies, including elements of vertical and horizontal differentiation which, together with change, form the "pillars" of every society (Steuer 1982a: 19). While *horizontal social differentiation*, characteristic of 'egalitarian' societies, ascribes status according to features such as age, sex, personal achievement, kinship etc. (i.e. intrinsic factors), *vertical social differentiation* describes the existence of hierarchies within a society and rather complies with M. Fried's (1967) definition of a 'ranked' society, i.e. access to certain statuses is restricted as hereditary inequality is implied and maintained (Clark and

Neeley 1987). The latter concept forms the basis of Steuer's proposition of regarding Alamannic social organisation as an *open ranked society* (Steuer 1982a: 519ff.), reflecting legal codes, amounts of *wergilds*, as well as 'quality groups' for grave good assemblages.

figure removed for copyright

Fig. 2.2: Model of Alamannic society, modified after Steuer 1997, Fig. 296, proposing a reflection of legal codes, amounts of wergild, as well as 'quality groups' of grave good assemblages.

Fig. 2.2 shows the complex societal division and configuration as proposed by Steuer (1982a; 1989; 1997). The material evidence of row-grave cemeteries indicates

- a social leading stratum (free, *liberi* or *ingenui*, divided into the simple free Alaman (*baro minoflidis*), free Alaman of mid-rank (*medianus Alamannus*), free Alaman of high rank (*primus Alamannus*);
- an intermediate stratum of peasants (dependants, serfs and slaves, *servi*);
- a low(er) stratum of dependants (half-free or freed, *liti;* slaves, unfree?).

Based on these elements, according to Steuer (1982a), Alamannic society was not characterised by the social affiliation to a legally defined rank but by positioning individuals and their groups according to rank, wealth and office, which could be acquired by military success and economic power. This implies a highly "mobile society", i.e. the society presented social permeability, allowing every individual to assume a different rank or position on their own efforts - "office ennobles". Steuer (1982a: 519ff.) principally rejects the idea that an individual maintains one social position, which ultimately a burial could indicate, because an individual was part of a familia, which in itself held a certain rank within a society; hence, an individual's position within the familia changes over a lifespan, as well as that of the familia within the society. Although no aristocracy would be bestowed by birth, very high-status ("élite-like") familiae of different, but variable rank could have existed, their position within society (as well as that of any other familia) subject to constant arrangement due to personal achievements and non-hereditary privileges awarded by the leading family. Social differentiation would have been based on acquired status and defined by its instability, since no social position would be permanently fixed (Steuer 1989). However, some restrictions applied; the free could marry individuals from other familiae and by this change or enlarge the group, while serfs could only marry among the group, enforcing a vertical stratification and social hierarchy between individuals and familiae, which would eventually be regarded as the main determinants of differences in burial wealth (Theuws 2009: 284). Through the distribution of land by the king (potentially via office holders in the provinces, Steuer 1997), landowning 'lordships'[33] or manorial regimes would develop and elevate familiae including their members to higher status. The concept of retainers (or fellowship, "Gefolgschaft"; Fig. 2.2) describes the relationship between a leader (a king or nobleman) and the warriors within his immediate following (Bazelmans 1991 ; Steuer 1992 ; Bazelmans 1999: 4; cf. Jentgens 2001: 125ff.). It is presumed that it was the right and duty of a free man to serve the military (Steuer 1982a: 528) and thus to be a warrior if called up to arms (Halsall 2003b: 53), even if leading a peasant-life otherwise. Only with advancing time and the intensification of agriculture and animal husbandry, a free peasant would not carry weapons any more, since his landlord (or manorial lord) would defend him (Steuer 1982a: 528). With regard to the burial custom, this model of an open, ranked society implies that burial did not follow a standardized behavioural pattern, as such homogeneity would, in fact, have marked the end of such a society (Steuer 1989). Instead, a burial practice that could vary in splendour, reflecting the "means" and status of the deceased and his *familia*, befitted a society that required the funerary rite for both presentation of respective ranks and the expression of behavioural patterns in life (Steuer 1989). Rank could be publicly affirmed in the context of the funerary ritual via quantity and quality of grave goods by the *familia* burying one of its own (Steuer 1989).

[33] Halsall (2003b: 47) suggests for Northern Gaul (and potentially other Frankish regions) that "by the later 6th century the social group from which the army was raised had become a class of landowners", as owning land, whether as a prerequisite for military service or a reward, would have been one of the main interests of Frankish warriors. This is reminiscent of Roman or later medieval structures (Bachrach 1993: 56f.), and it is questionable whether this would have applied to the Alamanni.

There are two major intrinsic problems to the argument for this approach, the main premises of which are summarised in Fig. 2.3.

- correlation between status of the living and equipment of the dead
- social organisation - model of an *open ranked society*:
    - ☞ social mobility
    - ☞ non-heritable positions, acquired status
    - ☞ fundamental importance of *familia* and household
    - ☞ the Alamannic "peasant-warrior"

Fig. 2.3: Summary of main premises on Alamannic social structure

Firstly, the perils of using Frankish and Alamannic laws as a basis for interpreting Alamannic social structure, especially for the early Alamanni, have been discussed previously (cf. Chapter 2.3.1). The model for Alamannic society as proposed by Steuer (Fig. 2.2) abounds with Merovingian status principles (cf. *Lex Salica*, Weidemann 1993). The principle of status elevation with rising proximity to a 'king' (*reges or basileus*, cf. Drinkwater 2007: 117f.) or leader is most frequently mentioned in early fourth century sources featuring "the Alamanni". These 'kings' rank in order from *excelsiores ante alios reges* ('superior kings') to *proximi reges* ('kings'), *reguli* ('lesser kings') and *regales* ('princes'), followed by *optimates* ('noblemen') and *armati* ('noble warriors'); it reflects a *Weltanschauung* that is inherent to late Roman chroniclers[34] and applies to all northern societies

[34] Ammianus Marcellinus (4th c. AD) names a number of *reges* who fought on the Alamannic side against the Romans (Drinkwater 2007: 217ff.), but no overall king is mentioned (however, regarding credence of such sources and Ammianus Marcellinus in particular, cf. Rosen 1970).

(Drinkwater 2007: 118). It is not at all historically identified what was meant by 'kings' and 'warriors' in Alamannic terms[35]. That this principle persists in the exploration of Alamannic social structure is rooted in the previously discussed historiography as well as the contextualisation with Merovingian structures. Concepts such as the right and duty to fight, and the existence of burials containing weaponry due to military service, but also the matter of landownership, are anachronistic projections from later periods onto the 5th - 7th centuries, and contrary to a dynamic model of societal functioning (cf. Hartung 1983: 122f.). The origins of the Alamanni as 'warrior bands' (Steuer 2006) feature heavily in interpretations on Alamannic life and social structure[36], yet they should not be by implication imposed onto the 5th and 6th century AD[37].

Servi, liberi, or even *nobiles* are, in fact, legal status groups in written sources, relating to strictly stratified societies and inconsistent with an open ranked society, which means derivations of archaeological groupings (such as, for instance, the burial of an *ingenuus* with a sword) should be completely renounced (Siegmund 1998b: 177f.). Categories such as 'free' and 'unfree' are highly debated with regard to the written sources[38], and distinctions between these groups are considered to have been very flexible, instead of rigid (Rio 2006). Use of the terms as shown in the above model (Fig. 2.2) is very context-dependent, and far more complex than

[35] As Siegmund criticises, despite any potential mobility, the rule of "Alamannic lords in Alamannia" prevails (Siegmund 1998a: 193).
[36] It has to be noted that Steuer (2006) describes the 3rd and 4th century, only to then continue with the Vikings in the 9th and 10th century, thus leaving it in the dark whether warriorhood could have been a "lifestyle" (Bodmer 1957) for the Alamanni during the 5th to 7th century.
[37] Warriors forming the barbarian "Alamannic" groups against which Romans had to fight are mentioned up to the 3rd century, then only again with the 5th century in Frankish literary sources, as 'war-bands': Sidonius Apollinaris "admonishes 'the *ferox Alamanne'* for 'drinking the Rhine from the Roman bank, and proudly lording it over both sides, a citizen or a conqueror.'" Drinkwater 2007: 330); Eugippius, "Life of Severinus', and Lupus of Troyes, early 6th century, speak of attacks together with Alamannic allies, "war-bands of Alamannic warrior society […] exploiting imperial weakness to show their mettle" (Drinkwater 2007: 334); Gregory of Tours mentions the encounters of Clovis with the Alamanni (Greg. Tur. *Hist.* II.30).
[38] In the *Pactus legis Salicae*, these terms only occur with regard to Romans and Germani, for instance (Wood 1994 102ff.).

Steuer's model allows. For instance, 'baro' (= 'man', Germanic origins) can be a free man of lower rank or an unfree of higher rank[39] in Frankish and Alamannic laws, 'minoflidis' meaning 'of lower rank' (Schmidt - Wiegand 1978). Legal historians stress "what we do find is a multiplicity of status and a multitude of grey areas" (Rio 2006: 38). The notion that slaves must have existed and were exploited by the Alamanni just as they were by other ancient communities (Drinkwater 2007: 136) is also by no means to be taken unreservedly. 'Slavery' or 'serfdom' merely aid the explanation of "poor" burials without any grave furnishing, as well as an interpretation of social consequences for these individuals, such as social exclusion or restrictions of free movement (Rio 2006). Ultimately, distinctions in status might have existed, and later descriptions of maidservants and the like may have had precursors in early Alamannic society, however, a direct mirroring of Romano-Frankish legal codices, last but not least in their burials, seems unlikely for the Alamanni, especially in generalised terms.

Secondly, and maybe more importantly, there is the question if and how different grave goods reflect social status in Alamannic burials, as Steuer's model relies on features such as the variety of differentiation of Alamannic male groups according to their armament, as mentioned earlier (cf. Chapter 2.2.1). Steuer agrees that the analysis of 'quality groups' according to Christlein (1973) can lead to convincing patterns in burial evidence (Steuer 1982a: 516), an opinion which is not shared by the present researcher. However, in later works, he also states that the system of 'quality groups' cannot work for a variety of reasons (Steuer 1989 ; Steuer 1997):

[39] Potentially, generally a '*barbarus*' is meant, i.e. someone of Germanic descent of non-Frankish ethnicity (Schmidt - Wiegand 1978: 23).

we encounter a change in grave good customs in the late 6th and 7th century, and additionally, it has to be noted that different customs existed in different areas of the Alamannia, and the quality and quantity of grave goods seemed to correlate with the age of the deceased in many cases. Altogether, other factors than only status add to the composition of grave goods.

Apart from these issues, the proposition of an open ranked society entails several questions that feature interesting points for the present study. This societal model does imply that the funerary evidence reflects differences in rank among and between *familiae*, and the question arises whether the instability of social position of Alamannic familiae within their society could not only be a reason for displaying wealth and power in the burial rite, but also for the variety of burial types and furnishings that one encounters in an Alamannic cemetery.

Furthermore, the question of the social position of an individual within such a society is unsolved: if status was not "fixed" at birth, as Steuer suggests, were all of these individuals "self-made men"? Of course, this extends to women as well, on whose social significance we do not have any information. In fact, the development of this societal model does, strictly speaking, first and foremost solely emerge from and rely on the graves of men, mainly alleged 'warriors', and this although we hardly have any information on the actual dynamics of warfare in relation to daily life at the height of the Alamannic era (Drinkwater 2007), considering how little we know about power relations. Regarding the nature of burial data and adding it to the aspect of such a model of society, how much of the social position of the individual within its *familia*, within society and of its *familia* in society do we see in a burial, how much is homage to the deceased, if such a habitus existed, how much is social display? Moreover, with such a societal and familial structure, the death of any member of society must have meant a shift in the social significance of others (cf., for instance, Halsall 1996).

Steuer's model of an open ranked society is based on material evidence and the correlation of grave goods with status, with Steuer himself pointing out that the objective of the burial process was to demonstrate the rank of the deceased *and* the bereaved (Steuer 1989). This goes hand in hand with early processual theory (i.e., for instance, Saxe 1970 ; Binford 1971 ; Tainter 1978), and integrating both approaches, we recognize much more important underlying patterns and implications inherent to a ranked society and its nature, or the absence of certain features, which make it interesting to scrutinize this model of an open ranked society further within the scope of a bioanthropological analysis and correlation with burial context.

The understanding of rank and its mechanisms from burial evidence has always been of concern in archaeological interpretation, and many researchers believe that the representation of rank via burial patterns underlies almost universal principles, namely a correlation between the level of status and the degree of expenditure[40] visible in a burial (Tainter 1975; 1978), including characteristics of the burial feature itself, the treatment of the corpse and the nature of grave inclusions. This implies a similar conjecture to Steuer's approach to Alamannic burial evidence - the higher an

[40] It has to be noted, though, that expenditure observed in the archaeological remains differs from the expenditure that was actually raised for the entire burial ritual (Parker Pearson 2001: 84)

individual's rank, the more elaborate the burial. However, instead of mirroring burial wealth onto status, there are far more factors involved which eventually form the rationale behind the present study - the element of social identities. The basis of early processual "expenditure theory" is formed by a combination of Saxe's argument (Saxe 1970) that burial ritual potentially involves all individuals who have been in some social relationship with the deceased at the time of death, and Binford's (1971) attribution of two essential components to the burial ritual: the '*social persona*' of the deceased, comprising a range of social identities an individual combines at any given point in time and in a social unit, as well as the configuration of this social unit itself in which the individual acted and assumed status.

Assuming a generally pyramidal structure of ranked societies, it follows that an increased ranking of status positions within a social system correlates positively with an increased number of individuals maintaining social relationships with individuals holding such status positions (Tainter 1975). A person ranking highly would thus maintain a comparatively large amount of such status relationships and consequently meet a larger amount of involvement in his burial ritual as well as cause a higher degree of disruption in the community by his passing away and with the expenditure for his burial (Binford 1971). Considering this, the importance of exploring social identities as the 'pillars' of societal complexity by all available means, i.e. archaeologically and biologically, via the individuals themselves, becomes apparent. Focussing on rank and status in the study of social identities seems straightforward when trying to examine social complexity (Meskell and Preucel 2007), however, without understanding the components, we cannot understand how rank and status function in a complex society, especially when expanding the considerations on what the burial evidence does offer the archaeological observer and including the significance of individual agency (Parker Pearson 1982; 2001; Giddens 1984: 14ff.). There is no need to develop a social model for the Alamannic population without any leads, instead, it is worthwhile to follow up Steuer's suggestion for an open ranked society (Steuer 1982a; 1989) in its widest sense. If this was the case, how did social identities establish themselves in this type of social environment, with neighbouring kingdoms and under constant threat of subjugation, and how did such a social gradation become manifest in daily life of different communities? Moreover, if a rigidly defined social hierarchy is absent, would that lead to an increased importance of various social identities and influence social movement in a way that can still be traced in the burial evidence? As Schutkowski states,

> *"[...] given the high social permeability and mobility of the society, in which the individual acquires his place in the social rank order by the assignment of privileges, archaeological findings do not permit a definitive statement about the original social group of the individual."* (2006: 180)

It is indeed not effective to determine social groups without finding out about the constituents that form the underlying basis regarding the mechanisms of societal structure. If we assume personal rank conditions within the larger framework of the mobile society, we have to consider the social individual itself.

"In the course of history those who have not had their heads cut off and those who have not caused others' heads to fall leave no trace behind. You have a choice of being a victim, a tyrant or a nobody."
Paul Valéry, *Analects*

3 Identifying Alamanni: Archaeological and anthropological perspectives

3.1 Societal structures in the Early Middle Ages: Relational complexities

Power relations

Considering what we do know of the Alamanni, it really does seem as if the majority of them left no trace behind, except their graves and bodies. However, this may only apply to the grand scheme of power and societal structures.

It is not clear from either historical or archaeological research how a system of power relationships, including segmentary levels of lineages, clans, up to the presence of dukedoms or kingdoms (cf. Chapter 2.3.2), applies to the Alamanni. Gregory of Tours (*Historiarum libri decem)* describes the Frankish conquest over the Alamanni; however, he does not name an Alamannic king but only describes an anonymous "*rex cum gentes superbia*" (Koch 2001: 20). In the historical literature as well as in archaeological interpretation, there is a lot of debate about the applicability of these terms to the Alamanni and the nature of their leadership, i.e. the use of terms such as *'reges', 'reguli'* and *'optimates'* for Alamannic leaders is merely an adoption of Roman terminology and hardly fit for application to a society that formed structures supposedly different to those of their opponents[41]. The proposed concept of "*Personenverband*" (an association of people, "personal association"; Steuer 1989), composed of a king and his followers, reflecting shifting personal relations as a fundamental concept and forming the prevailing power structure in the Merovingian realm, can hence only be verifiable in the aspect of its driving principle: allegiance throughout society, both as a stately and familial concept.

With regard to the notion of a "ruling class"[42] (the *gentes superbia*?) or élite in Alamannic society (its existence highly debated, e.g. Hartung 1983), history offers an interesting perspective that may have an effect on the detection of such high status individuals and their burials in the cemeteries under study, as well as on the societal structures to be explored. While aristocracy, the "rule by the best", has no necessary legal or constitutional base and may be acquired or lost from one generation to another and even within them, nobility describes a privilege that is given by birth, closed off towards lower ranks, and can only be lost in exceptional circumstances (Weidemann 1993 ; Halsall 1995: 24; Schneider 2001: 17f.). Both terms may, however, comprise the élite of a society. Interestingly, the *Leges Alamannorum* describe no aristocrats for Alamannic society[43] (Schott 1978b). It has been suggested, on the basis of archaeological evidence (i.e. the absence of definite "élite burials"), that Alamannic high-status families, few in number, fled down the

[41] Indeed, the connection of weaponry, economic power and legal status derives from what we know from ancient Greece and Rome (Steuer 1892a: 30).
[42] it is important to distinguish between a group defined by juridical definition and, more aptly in these circumstances, a group that hold privileges by status, descent and property (Schmauder 2003).
[43] I.e. in the later *Lex Alamannorum*, the *Alamannus primus* does not occur any more, while wergild sums are levelled to the circumstances (Schneider 2001: 27). However, Wenskus (1961) points out that *wergild* in the *Leges* may simply not have been applicable to the élite, as the proximity of these families to the king would have made a compensation payment void.

Middle Rhine area after the Frankish conquest and their associated disempowerment (e.g. Martin 1997a). Across the Alamannia, individual cases of high-status burials belonging to Alamannic élite families who tried to integrate with Frankish structures in order to maintain their status may have occurred, but overall, an unbroken tradition of such burials in cemeteries of the Alamannia cannot be traced, archaeologically or textually (Schmauder 2003). The idea that the Alamannic nobility tried to preserve their existing positions of power, also under conditions that meant fundamental changes in power, and assimilated, with the effect of an exchange between social élites (Brather 2000: 167) that would ultimately be visible in the burial record, is countered by Schmauder (2003). He advises that a sudden loyalty of the Alamannic élite to the Franks would not pay justice to the written as well as archaeological evidence. It remains to be seen whether bioarchaeological evidence would support any of these directions, by revealing distinctly wealthy burials with individuals whose biological constitution could indicate a distinct difference to the rest of the population.

Yet, while the question of how this population was ruled certainly plays a role when considering the entirety of the societal structure, it is not of paramount importance to be certain about their leadership when exploring this society from an individuals' level, as we cannot be sure what the power relations were in pre-Frankish times and how far Frankish control really extended, especially into more rural areas of the *Alamannia*. This study, by the nature of its approach, seeks to decipher Alamannic society by looking at the remains of all individuals, regardless of the status implied by quality and / or quantity of grave goods and without trying to pinpoint the élite as a paramount focus. It is the entity of a cemetery population that provides information about the life in a settlement, as it is the entity of a living population that creates a society and its structures, movements and changes.

Clan and kinship

Contrasting the general alliance of people ("*Personenverband*"), the principles of clan ("*Sippe*"), as a decentralized gentile structure, and, more broadly, kin groups[44] are well attested in German scholarship and research on Germanic societal structures (Murray 1983 ; Geuenich and Keller 1985 ; Hummer 1998a: 23). For Alamannic society, the existence and meaningful strength of kinship - both biological (i.e. static) and social (i.e. fluid[45]) kinship (Härke 2000 ; Jones 2010) - is implied by the descriptions in the law codes, which primarily are about compensation, retaliation, and reception of wergild (Schmidt - Wiegand 1997). Indemnity was a matter between the offender and the entire *familia* of the aggrieved party, the delinquent's entire kin was exposed to retaliation, and compensation given from one kin group to the other, all depending on internal structural relations[46] (cf. Murray 1983: 18f.). Beyond such legal functions[47], the existence of kinship structures such as provided by a *familia*[48] are of great significance with regard to the burial ritual and the furnishing of the grave: for instance, if the kin group laid to rest an impoverished individual - presuming the assumptions are correct and the societal standing of an individual is determined not only by solely the membership in a familia, but also by the fulfilment of particular

[44] "Sippe" includes the concept of a fixed kin group (defined by common agnatic lineage) as well as that of a shifting kin group (comprising the whole circle of an individual's blood relations) (Murray 1983: 14ff.).
[45] i.e. unrelated individuals forming a "unit", for instance, by marriage
[46] For instance, maternal kin may have received and paid different sums than paternal kin, similar to structures known from the Anglo-Saxons (Murray 1983: 18).
[47] which also included "oath helping" in legal processes, for instance (Murray 1983: 157ff.)
[48] The family, i.e. the core of a household, was the binding element, and even the Merovingian and later Carolingian rule was determined by personal relations with other noble families (Steuer 1989: 100; Moreland and van de Noort 1992: 321).

roles within the *familia* -, would the individual have been buried with grave goods, or a great abundance of them if the kin group wished to demonstrate its status which may have been wealthier in general, or would no grave goods be bestowed as the individual was poor? On another note, what were the implications of an existing kin group if a child died before its parents? The rapport of all members of the kin group (e.g. a *familia*) would have been of importance to the representational meaning of a burial. While the measure of kinship organisation is not part of this study[49], it is important to acknowledge its nature as an essential part of the Alamannic social network[50], and of the compositional framework of social identities (Lucy 2002).

Social relationships

The general principles of allegiance and loyalty are inherent to the ideas and principles pertaining to Alamannic society at all levels, from "Personenverband" and warrior fellowship[51] to, on a local societal and personal scale, kinship and *familia*. To this could potentially be added an element that occurred in Germanic, Roman and Frankish society and finds some reflection in textual sources on the Alamanni, the concept of *amicitia*[52], describing a friendly relationship with the responsibility of loyalty of both parties, only possible among individuals of the same rank (Althoff 1998). Interrelationships such as the above, in addition to the more "discernible" factors of age and gender as agents in social relationships (Halsall 1998b), were of

[49] Attempts have been suggested, e.g. by Murray 1983: 157ff.
[50] A society that mainly or only defined itself in terms of kinship relations could be defined as a 'simple society' (Ausenda 1998: 374), however, considering the textual evidence, Alamanni cannot unreservedly be categorised as such. Ausenda's suggestion to assume rather "simple" structural relationships as a point of departure, rather than complex "kingdom"-associated structures (Ausenda 1998: 375), seems adequate, considering current knowledge.
[51] interestingly, "Gefolgschaft" = *lat.* 'comitatis', *germ.* 'truth' or 'trustis' (from 'druhtiz' ≈ war band on military campaign) (Weddige 2006: 215)
[52] i.e. Germanic "*friuntscaf*", Roman *"amicitia"*, a friendship based on the pledge of loyalty (Althoff 1998)

particular importance in Merovingian society, as they formed and transformed an individual's societal position. If these principles provided the basis of the society in focus, then the concept of social mobility would have been plausible and effective for every member of society. At the same time, it conveys the inefficacy of hitherto historic-archaeological approaches to define an Alamannic society, as the complexities of social relationships are not being accounted for when looking for reflections of status in the burials.

The proposed model of an open ranked society suggests that social positions can be achieved, instead of being ascribed. However, seen in the theoretical context, for instance within anthropological role theory, describing social positions as correlating with the rights and duties towards a social unit, social identity in the main is always ascribed as well as achieved, putting it in contrast to personal identity which comprises all aspects of an individual's self that do not influence and change its status relationship within the society (Goodenough 1965). Considering these differentiations, the complications in interpreting social complexity from material culture become even more apparent, as strictly speaking, an analysis of burial evidence would have to take into account both forms of identity. Not only is a burial a selective depiction of an individual's place in society (Parker Pearson 1982: 112), but whatever the motives for representation displayed in the burial may have been, the personal aspect - death as a deeply moving and personal experience (Tarlow 1999: 125) - as well as the facet of creating memory (both personal and social, Williams 2006a: 3; 11ff.) through the burial rite cannot be neglected in the interpretation of grave goods. The biological evidence, however, permits establishing a profile of the individual, which then can be used to create patterns from burial evidence.

There are many facets to the term "identity" with regard to the Alamanni. An important, comprehensive element is the multiple ethnic identity of this population, a matter widely discussed especially with regard to the ethnogenesis of the Alamanni and the conquest by the Franks, but also with regard to the Burgundians and Merovingians, their contemporary neighbours (e.g. Pohl and Reimitz 1998 ; Siegmund 1998a ; Wood 1998b ; Burmeister and Müller-Scheeßel 2006). Yet, when discussing the Alamanni as a living population with attention turned to inner, local societal structures and daily life, it remains to be asked how identities of individuals within their *familia* and their community formed and existed. How much influence did the ‘ethnic identity‘, in historical accounts so often emphasized, really have? What were the more important factors forming an individual's life among its community and characterising the life course of an Alaman? Only few attempts have been made at understanding Alamannic society and, implicitly, culture, from aspects other than ethnicity, hence archaeological interpretation mostly revolves around the idea of a ranked society which seems consistent with late Roman descriptions, classifying their (mainly male) members into categories associated with warriorship and allegiance to a king. In fact, the variable of (social) rank seems prepotent when it comes to the identification of individuals, while it is little acknowledged that an individual is composed of multiple identities whose complex framework is constantly modified. It remains to be understood how Alamannic society functioned, especially under the interesting aspects of a population that brought with it a diversity of local customs and formed itself amidst other groupings in early medieval Europe, encompassed by populations that moved within long-defined "laws of society".

3.2 A question of identity

3.2.1 Ethnicity and ethnic identity

Biological ethnic identity

Regarding the geographical and temporal setting of this study, omitting the topics of ethnicity and ethnic identity as a focus for exploring social mechanisms seems almost unthinkable. Yet, it is due to these settings that this topic has been the predominant, if not sole, focus of historic and archaeological research with regard to the exploration of the Alamanni (e.g. Siegmund 2000 ; Jentgens 2001 ; Brather 2004a ; Brather and Wotzka 2006). Ethnicity, an ideological feature[53] (Geary 1983), a cultural identity that would be actively used in the funerary context to create an ethnic identity, particularly in a period when new political units were being constructed (Halsall, in reply to Siegmund (1998b: 205; Halsall 2007: 35ff.), is intricately intertwined with concepts of ethnic identity which is, among other factors, defined by biological and geographical origin (Härke 1990; 1997c) but turned into a cultural construct by endeavours of affiliation with influences such as political power or social roles (Curta 2007; Lucy 1998; Wenskus 1961). Ethnic identity does form one social determinant that certainly contributes to social questions, as, for instance, the analysis of weapon burials in Anglo-Saxon contexts

[53] "Medieval ethnicity doesn't [sic!] have anything to do with blood." (Wood, in discussion to Siegmund (1998b: 206)

has shown (Härke 1992) and may prove of importance when it comes to deliberation concerning the weapon burial custom, and is a component to be kept in mind in the complex of analysing social identities. It is, as all other social identities, of a 'constructed' nature, yet in this it is even harder to apprehend than any other component, because its reflection in the burial record is based on a deliberate choice of depicting affiliation with a certain cultural identity and marked by a high degree of symbolic character in material culture (Curta 2007 ; Meskell and Preucel 2007: 128).

Migrations and identity shifts

The study of peoples during the Migration period and their subsequent formation have been heavily subject to the differentiation between locals and foreigners: in terms of biological identity, movement of traditions, and the role of the élites in the mechanisms of ethnogenesis, assimilation and power construction (Urbańczyk 2008 ; Hakenbeck 2009; 2011 ; Brather 2010: 29); the diffusion from the suspected origins of burial rites (in particular, the custom of row grave cemeteries or the weapon burial rite) from Germanic populations (e.g. Salin 1952 ; Périn 1981 ; Halsall 1992 ; Périn and Feffer 2001 ; Theuws 2009); with regard to the Alamanni, their *gens* as opposed to the Franks (Hummer 1998b ; Wood 1998b ; Brather and Wotzka 2006). This is not only due to a constant discourse on otherness that permits the definition of power relations in early medieval Europe (Theuws 2009), but evoked by the "ethnic paradigm" (Brather 2000): in archaeology, the identification of ethnic groups that can be distinguished from each other by their material culture finds great favour. Particularly with regard to migration period populations, ethnic groups are likely to be considered as units which combine a common origin, culture and language, composing ‘who they are’ (Veit 1989 ; Jones 1997: 65ff.; Heather 2008), thus, they can be studied as entities and opposed to each other in binary fashion. The material evidence retrieved from their burials is unconditionally interpreted as an expression (either in type or origin) of individuals’ identities ("archaeological cultures", Kossinna 1928) and, in combination with surviving aspects of the funerary rite, regarded as if reflecting true conditions of ethnic origins, despite all the aforementioned limitations and recent criticisms of many researchers (e.g. Jones 1997 ; Pohl 1998 ; Brather 2002 ; Effros 2003 ; Theuws 2009: 27ff.)[54], albeit some of them still acting within these parameters (cf. several papers in Gillet 2002). In some cases, and more closely pertaining to this study, the skeletal evidence has been consulted. Huber (1967) used cranial morphology in order to support the thesis that Alamanni (dolichocranic) would have always been buried with weapons, in contrast to indigenous Romano-Celtic individuals (brachycranic) who would be found without weaponry (discussed at length by Effros (2010)); Czarnetzki et al. (1983) tried to correlate status groups (‘nobility’, ‘free’ and ‘unfree’ individuals) with craniometric data of skeletons from Alamannic cemeteries. Finally, and considerably more expediently, the role of women was explored in the social context of exogamous mobility and ethnicity (Knaut 1993: 430; Hakenbeck 2009 ; Hakenbeck *et al.* 2010), as female artificially deformed crania[55] (“*Turmschädel*”) are occasionally found among the human remains from Alamannic cemeteries. While only isotope analysis can shed light on the mobility of these individuals (Hakenbeck

[54] Jones (1997: 52), for instance, deems is unacceptable to look for “a bounded, homeostatic, integrated and essentially static whole”.

[55] These are usually cone-shaped, elongated crania with a flattened forehead, commonly assumed to have originated in central Asia during the 1st century AD and reaching a peak with the invasions by Hunnic populations (Heege 1987: 65ff.; Wahl *et al.* 1997 ; Hakenbeck 2009).

et al. 2010), the occurrence of female skeletons exhibiting these cranial deformations are of interest with regard to the question of status[56]: on the one hand, these women are considered as 'status symbols' themselves[57], brought into Alamannic local populations by men to substantiate their high status (Drinkwater 2007: 141), on the other hand, they are frequently found without any grave goods, which is associated with them having been foreigners to the social group in which they died (Hakenbeck *et al.* 2010). It becomes quickly visible that the role of social identities, though intertwined with ethnic identity, moves into a more complex framework of social interrelations.

> *"If ethnic identity were an identity defining overarching groups in society, why would this identity prevail in the burial rite over other (local and social) identities*?"
> (Theuws 2009: 314)

This question leads this study to focus on other components of societal mechanisms and social identities than ethnic identity, as it is believed that ethnicity does not prevail over other identities that can be explored in the Alamannic burial record. With the great majority of research on the Alamanni concentrating on their ethnogenesis and questions of ethnic identity, it is essential to explore the Alamanni behind these concepts, focussing on those identities that are primarily explorable by bioarchaeological means, as with reference to Tyrrell (2000: 139), cranial shape or other skeletal traits do not make the Alamanni any more than the typological classification of a bow-brooch or belt buckle.

[56] Although Steuer (1998: 305) suggests that cranial deformation could be a result of a diffusion of female fashion instead of invasion; Crubézy (1997) argues that cranial deformation may have been practiced by indigenous people adopting outside customs, and that individual members of ethnic populations could not be defined by such a custom.

[57] "If having a Germanic wife was seen as a mark of high status [i.e. because only the wealthy could bring dependents from *Germania libera*], others would have striven to bring one in under easier conditions of permanent settlement, along the lines of communication that linked the Vistula, the Oder and the Elbe to the Main and the Rhine." (Drinkwater 2007: 141)

3.2.2 Sex and gender identity

Skeletal sex and archaeological gender

Gender, the cultural interpretation of bodily differences (Gilchrist 1999: 1; Sørensen 2000 ; Sofaer 2006: 7), has to be positioned relationally to other markers of social identity such as age and status and contextualised with regard to the social space of an individual (Brumfiel 1992). While the skeleton provides information on the biological sex, the burial context suggests the gender identity of an individual, as the interpretation of gender underlies cultural variables (Stoodley 1999: 1ff.; Gowland 2006) and allows the construction of social categories, such as 'masculine' and 'feminine' (Armelagos 1998). Distinct items of material culture, e.g. jewellery for females or weaponry for males in this context, are automatically associated with individuals of particular sex, to the extent of determining the sex of an individual according to the grave goods instead of biological parameters (Lucy 1997 ; Effros 2000 ; Lohrke 2004b) and categorizing the grave goods into 'male', female', and 'gender neutral', a method that, altogether, is highly problematic (cf. Gilchrist 1997: 44ff.; Knüsel and Ripley 2000), yet generally deemed acceptable in Merovingian archaeology (e.g. by Halsall 1996 ; Brather 2004b). It relies on the generally accepted notion that Merovingian burials offer the scholar a marked display of grave good items according to sex, age and status (Halsall 1996 ; Lohrke 2004a: 85; Härke 2011). The traditional gender associations of grave objects found in Alamannic burials can be found listed in App. 2, Table 1.

Of interest to this study is the relevance of sex and gender to the *social persona*, its interaction with other aspects of social identity (especially age), and its degree of influence on life and social standing within the Alamannic society. According to Halsall (1996), biological sex constitutes a vertical border, to which all other identities are subsidiary. Gender is created and substantiated in the space that men and women share (Gilchrist 1994); this includes the spheres of settlement and physical space, but also the spaces of, for instance, occupation or activity, as well as of responsibilities and significance within a society, the “social space”. It becomes clear very quickly that interpretations on gender identity are almost invariably accompanied by age identity and most often intertwined with the question of status. This is coupled with gender roles, i.e. social relations, behaviours, as well as activity patterns of men and women within the society (Arnold 1995).

Gender identities in the Alamannia

While the male is *de rigueur* associated with the “warrior” in Alamannic society, hardly anything is mentioned or known regarding the role and influence of women - they are lost in a gender-neutral past, as Gilchrist (1997: 44) suitably puts it. If a reference is made, it is to the role of women during the migrations and invasions and their significance as a bearer of ethnic identity (e.g. Bitel 2002: 57ff.; Effros 2004 ; Lucy 2011). It is only in the *Leges* that we find indications as to the status of women in different situations, but aside from the mentioned complications in relating the law texts to Alamannic life (cf. Chapter 2), discrepancies between cemetery data and the laws have been, not surprisingly, noted by several researchers (Halsall 1996 ; Siegmund 1998b). For instance, according to the *Leges*, only (?) a fertile woman equals an expensive woman, deduced from the amount of fines the offender had to pay when harming a woman of that age, but this not being exactly defined (Siegmund 1998b: 208). This contradicts the burial evidence that seems to suggest that older individuals tend to be endowed with wealthier grave goods (Siegmund 1998b: 208). It is possible that the communal role took over the familial role (cf. McNamara and Wemple 1973), explaining the burial wealth in graves of at least higher ranked women in the light of status relationship theories. However, the question remains if this only applied to high status women, if phenomena relating to burial wealth distribution are equal across the entire gender, and if a potential reduction of the social role with the children reaching adulthood applied to both sexes.

Furthermore, it would be of interest whether a woman's social position was defined by her husband or other men in her family (Halsall 1996). Interestingly, many wealthy graves, in larger cemeteries often also "founder graves" (burials dating to the earliest phase and therefore attributed to the settlement's founders), mentioned in the archaeological literature (for example, at Pleidelsheim (Koch 2001), Zeuzleben (Steuer 1989), or in the small 7th century burial ground of Niederstotzingen (Paulsen 1967)) seem to be those of women, determined either by artefactual "sex" determination (e.g. in Niederstotzingen by the remnants of beads within the otherwise empty grave, Paulsen 1967) or by anthropological analysis of the skeletal remains. Yet, either it is assumed that those women were the wives of wealthy leaders within a group, her wealthy burial reflecting his status in society (Steuer 1989), or it is simply omitted in further discussions. This leads to the question of the social role of a woman. Was her social role entirely defined by her husband, who, should he pass away, leaves her either with no status of her own or transferring his status onto her? Did her importance decline as soon as her children grew up? Both variants would leave the early medieval woman without any social power of her own, but this does not correlate with the archaeological interpretation of the Alamannic "founder graves" in Pleidelsheim (Koch 2001), nor does it explain the presumably wealthiest - woman's - grave on the burial ground of Niederstotzingen (Paulsen 1967).

Overall, the funerary remains are readily read as supporting the images of "armed warriors" and "adorned housewives" (Härke 2011), and thus archaeological sex determination justified and gender roles attributed. Gender is seen confirmed as manifested in dress components, jewellery for the women and weaponry for the men (cf. App. 2, Table 1); items such as spindle whorls and weaving swords which are commonly associated with female work (Brush 1988 ; but also fertility, e.g. Kehoe 2000) define the female role in Alamannic society (Bank-Burgess 1997), despite contrary references in the narratives of Gregory of Tours, for instance, where weaving is implied as an occupation for both genders[58]. To trace the gender roles in terms of lives lived and activities for both males and females at Pleidelsheim and Neresheim, is a first illuminating step to answering such questions on the basis of evidence by the people themselves. Moreover, if traditional gender attributions of grave goods, beside dress components, are substantiated in the Alamannic burials as they seem to be for other burials in the Merovingian area, it may confirm an interesting suggestion made by Härke (2011): especially in a highly mobile society, re-affirmation of gender roles in death might have been sought, although

[58] Greg. Tur. *Hist.* VII.14: "[…] his father sat at a weaver's loom and carded wool."; Greg. Tur. *Hist*. IV.25: "[…] watched the man preparing wool for the royal household."; Greg. Tur. *Hist.* IX.38: […] the women who worked in the spinning and weaving room […]"

these were much less distinct in life. This bears relations to the need for a confirmation of status in general, referring to Childe (1945) who proposed the display of wealth in the burial as an indicator for status competition in unstable societies.

3.2.3 Age identity

The three types of age - interdependent entities and perceptibility in the burial record

Age is a hugely important factor for the understanding of social dynamics and must be seen as a varied and variable physical as well as social process (Hockey and James 2003: 5; 24ff.; Gowland 2006 ; Sofaer 2006: 117ff.). Not only is age identity a significant element through which individuals structure their life course, but also emerging from and through social relationships and has thus to be seen in synthesis with other social processes (Jenkins 2004: 12). The distinction between biological (physical), chronological (amount of time passed since birth) and social age (within socially constructed norms) (Gowland 2006) is of special interest in the attempt to interpret burial evidence: rather than biological changes in the course of ageing being a stimulus for social recognition and an individual's position in society, in most societies, age identity is mainly related to the fulfilment of social roles, not to the biological state of being (Gowland 2006). The analysis of biological age, in concurrence with the information retrieved from burial evidence, can lead towards a determination of these passages and divergence of age categories. Crawford (1991; 2011) draws attention to the problems that can result from mapping biological terminology onto social interpretation: terms such as "child", "subadult", or “adult, used in anthropological analysis, are likely to differ from socio-legal categories that may be associated with them (cf. also James 2004) and have thus to be distinguished from each other in the biological and social interpretation of evidence.

The ‘rites of passage’, identified by Van Gennep in 1908 (Van Gennep 1960), are an important concept for ceremonial age-related subdivisions in tribal societies, comprising three subordinate rites, i.e. separation, transition and incorporation (Van Gennep 1960: 3ff.). Regarding more complex societies, a variety of other factors often obscures those rites, but they are present nonetheless. This concept describes how in the course of a lifetime, an individual experiences several changes of status, by passing through certain distinct stages ("social locations", Hockey and James 2003: 24) common to life in general[59] and to most societies. In the archaeological context, it is expected to find indicators of these changes in the form of distinct material evidence or burial context, pointing to the stage of life this individual has been in at the point of death. The passage from one phase to the next detaches the individual from its previous social position, with the intermediate (‘liminal’) state sharing features of the phase before, after or even of neither (Hockey and James 2003: 25). Taking it one level further, some theorists imply that with every change, the old self disappears in order to give way for the new self (Metcalf and Huntington 1991: 30).

Whether this applies to what can be found in the present burial evidence is questionable, as not enough is known at this stage about customs in Alamannic

[59] Note that also the burial rite itself is one of such rites of passage - the deceased is assigned a new status.

society regarding either transitions such as marriage or processes that accompany the passage from one rank into another. If answers are sought in the *Leges Alamannorum*, what is found is, for instance, that marriage signals the end of childhood[60], but no age limit is described (Lohrke 2004a: 30). If the concept of a liminal state in between stages applies to this society, what would be the funerary evidence we are confronted with in the event of an individuals' death during such a liminal phase? Taking a life course approach (Gowland 2006 ; cf. Crawford 2011) provides a suitable solution to the exploration of age identity in Alamannic society: The reconstruction of the male and female life course, by identification of age thresholds through changes observable in grave good patterns in association with the consideration of biological age and sex and, possibly, patterns reflected in skeletal health and modes of activity, does not only help to shed light on plausible liminal stages for all members of society, from childhood to old age, and potentially differential meanings of the social significance of individuals within local societies, it also provides a framework for the individuals as actively acting within and being influenced by social context and structures (Glencross 2011). All aspects of social identity (e.g. Halsall 1996 ; Sofaer Deverenski 2000a ; Stoodley 2000 ; Gowland 2006) and skeletal patterns of health and activity (e.g. Härke 1990; 1992 ; Glencross 2011) can be considered within this framework.

With regard to such an approach and the grave furnishing provided in Alamannic cemeteries, the distribution and wealth of grave goods in relation to age is an important point of interest. Siegmund (1998b: 180f.) demonstrated for various Frankish cemeteries that with increasing age, an increase in burial wealth could be

[60] With regard to offenses such as rape and molesting of women, there is a distinction between virgins and wives (*Lex Alamannorum LIII, 1-2 [LV]* (Lohrke 2004a: 30)).

observed. In two cases, older women, i.e. beyond child-bearing age, received comparatively precious grave goods. The same could be demonstrated for males: old individuals, hardly fit for military service, are comparatively well armed in death. The opposite pattern was found by Halsall in 6th century Merovingian cemeteries in Northern Gaul (Halsall 1996): Here, children seemed to have been considered neutral. In adolescence, males usually remained artefactually 'neutral' while females received their full complement of gender-specific artefacts, usually jewellery. Only from about the age of 20, males also received gender-specific items, in particular weaponry. From the age of *c.* 40 years, artefacts in graves decline for both males and females with only very few objects found in the graves of old individuals. His studies also suggested regional variation in these patterns that can be also expected for Alamannic cemeteries.

Seeking diachronic comparisons for such customs, a look at burial rites in *Germania libera* (1st - 4th c. AD) indicates that the young were endowed with richer grave goods than their elders, 'mature' and 'senile' (Gebühr *et al.* 1989: 92ff.). The question is whether the Alamanni followed, in principle, the Germanic people, rather than their opponents who conquered them eventually, or if those patterns vary regionally to such an extent that we have to assume underlying mechanisms to the relationship of age, gender and grave good patterns that are entirely dependent on other factors. It will be of interest to explore whether there are parallels to the model suggested by Halsall and implied by Germanic customs at least until the Frankish conquest and up to the mid-6th century, with changing patterns of burial practice with the implementation of Frankish practices, as a certain element of inconsistency with respect to age-related funerary practice can be expected with the political change. The acquisition of an accurate age profile forms the basis of a meaningful comparison of grave goods with the age of the individuals in order to establish similar models for the cemeteries under study.

Regarding Merovingian and especially Alamannic societies, very little has been done in the aforementioned aspects - the focus was, if any, mainly on the weapon burials. This starts with children and the evidence of weaponry in the graves of young boys, testifying to their “future” as Alamannic warriors, although, in general, it was only by the 1990s that child burials received their own attention in cemetery catalogues and descriptions[61] (Lohrke 2004a: 37). With regard to Alamannic burials and an anthropological age estimation, it will therefore be especially interesting to reflect upon whether it is conceivable that “weapon child burials” existed, and whether presenting a young boy with elements of weaponry as grave goods (symbolic, possibly even indicated by "child-size" versions of sword or seax, or functional, Effros 2003: 125), could reflect a liminal state during the life course. The relationship between age categories and “warriors” is of great importance to the interpretation of Alamannic society, not only with regard to the question whether all men, or any men, were warriors, or whether the weapon burial rite was merely symbolic, but for the overall functioning of local societies and Alamannic social organisation. In Tacitus’ descriptions (*Germania XIII*), some indicators imply age grades which are similar to what one could expect from any society involved in warfare: young warriors follow their chief in war or raids by being, according to

[61] In the first mention of children’s burials, the graves of girls were acknowledged as part of the female burials, while the graves of boys were not listed among the male burials. U. Koch was the first to devote separate sections to the grave goods from burials of men and boys and women and girls (Lohrke 2004a: 37).

their level of mastery, divided into *gradus* and, according to their level more or less close to their chief (Ausenda 1998: 382). In Anglo-Saxon society, the relationship between the elders (fathers and lords or kings) and the young warrior-follower is assumed to having been highly intertwined with age identity, concepts of loyalty and worthiness[62], and transitional stages from boyhood to adolescence to adulthood, as the ritualized giving and receiving of weaponry marks these passages, the becoming of a noble man, and, eventually, the weapon burial rite (Bazelmans 2002). Härke (in discussion to Ausenda (1998)) points out that even in modern times, in societies with age grade organization, the older, more experienced warriors are closer to their leader than the younger, inexperienced ones. In many post-Roman societies, we find such an organization, which implies that this kind of society is more complex, as it not only follows kinship and loyalty patterns, but also by having age as a determining factor. One may conclude that this would be one of the underlying reasons for interpreting the presence of two or more males in multiple burials in Alamannic cemeteries as a leader and his 'inferiors' (for example the triple burial at Niederstotzingen, Paulsen 1967) - the principle of fellowship would extend into death, an assumption that is still often repeated in the attempt of explaining multiple burials with same-sex individuals.

The aspect of belonging to a certain age group changes an individual's behaviour, especially if this implies the passage from boy to man and therefore warrior, for example. It also changes the behaviour of the relatives who, in the event of death of

[62] In the old English heroic epic poem *Beowulf*, a man is "by weapons made worthy" (*waepnum geweorđod*), i.e. he passes from adolescence to young adulthood in service as a warrior-follower and later, if successful, to "full" adulthood as a man of virtue, marked by the reception of gifts from his father and king (Bazelmans 2002: 78).

this individual, would signify a certain expectation or indication of status in an age group with their composition of burial custom. The examples reveal even more interesting aspects, augmenting the implications of social identities on the proposed social structure. Was social structure largely formed with emphasis on one single aspect of social organization, i.e. was any particular identity, especially age, of particular importance and power, or did other structuring principles, for instance, rank and status in this societal model, moderate the influence of a social identity such as age?

Alamannic (?) life courses

Isolated references to life course events exist for the Alamanni, mainly drawn from interpretations in the *Leges* (i.e. largely from the Salian and, occasionally, the Alamannic laws; cf. Chapter 2.3.1). That the Frankish laws apply to (free) people living according to Frankish *mores* is evident by paragraphs such as on the killing of a free Frank or Barbarian living by Salic law, which amounts to 200 solidi (8000 denarii; Murray 2000: 536). Hence not only admonition by some historians (e.g. Murray 2000: 533), but the reading of the *Leges* itself cautions against the transferral of their statements onto interpretations about Alamannic life. Regarding the coming of age, for instance, we learn that the age of 12 had some significance with regard to legal responsibility (*Pactus Leges Sal.* 24.5; Siegmund 1998b). The *wergild* for killing a free boy below 12 years of age amounted to 600 solidi (24000 denarii, *Lex Sal.* 24). Murray (2000: 535) mentions that the earliest redaction of the law code sets the age at 10 years[63], while the Carolingian redaction merely states that this applies to a boy “without his hair cut”.

No coherent account for Alamannic life courses has been approached to this date, with the exception of outlines provided by S. Brather (e.g. 2004b; 2005; 2008b; 2009)[64] and, to a more general extent and in direct comparison to the Franks, by F. Siegmund (Siegmund 1998a; 1998b). These researchers present the currently only approaches to life course descriptions for the Alamanni in an attempt to arrive at a structural categorisation for males and females in various age categories in this population with view to social structure (i.e. the position of the male or female individual within the social community). Brather (2004b; 2008b) attempts to reconstruct the Alamannic life course for men and women by associating the “value” of individuals as indicated by the law codes and the wealth of grave accoutrements found in their burials, considering the elements of age and sex as influential to the grave good custom and its representation of status[65]. Despite aforementioned problems with regard to consultation and interpretation, Brather primarily considers the Frankish laws, as they stress the importance of the age of the harmed individual[66], while the Alamannic laws, with very few exceptions, list sex as well as, in certain cases, social rank as determining factors for the value of the wergild (Brather 2008b: 267).

[63] Also early Anglo-Saxon laws indicate an important legal threshold for the age of 10, this initiating the age of inheritance and criminal responsibility (Härke 1997a).
[64] These proposed models are repetitions of one model, under different aspects of ethnicity, dress or identity in the burial.
[65] He bases his investigations on anthropological data on age and sex provided by cemetery catalogues, and accepts, even though with a word of reservation (Brather 2004b: 7), the archaeological sex determinations that are commonly assumed if anthropological sex determination is not possible, or if the grave goods propose a different gender. Despite attempts to later include aspects of identity, such as ‘occupation’ (Brather 2004b; 2010), his interpretations do not make use of anthropological data beyond those of age and sex, given the lack of them in archaeological reports on Alamannic cemeteries, and are a purely historical-archaeological inference.
[66] At another point (Brather 2004b), he argues that the Alamannic laws revolve more around bodily harm, not murder. It is thus not clear why Frankish law codes were of choice in this reconstruction of Alamannic structures regarding life and status.

From the *Leges Francorum*, Brather observes the following (cf. Fig. 3.1): The "regular" sum for compensating the murder of an individual was costed at 200 solidi. Harming (i.e. killing) newborn girls[67] (Brather 2008b) would have been punished with the extraordinary compensation sum of 2400 solidi (*Pactus Leges Sal.* III. 104.8), twelve times the 'normal' average and four times as much as for stillborn or newborn boys (600 solidi, Halsall 1995: 72). It must be added here that the naming of a compensation sum for girls is considered a later addition to the paragraph, which first only mentioned a sum of 600 solidi if the child was (to be) a boy (Eckhardt 1962 ; Elsakkers 2008: 235). Considering the Alamannic law codes[68] (cf. Fig. 3.2), causing a stillbirth or the death of a newborn (younger than nine days) was to be compensated with 40 solidi, however, for both boys and girls (*Pactus Leges Alam.* XII, I, 108). Interestingly, the later redaction of the *Leges Alamannorum* differentiates between a fetus that is not fully formed and shows recognizable sex and one that is; if an abortion happens before the foetus is "*iam non fuit formatus in liniamenta corporis"* (*Lex Alam.* 88.1), the compensation amounts to 12 solidi. Should the fetus be formed so that sex is recognizable, it would be 12 solidi for a boy and 24 solidi for a girl (Elsakkers 2008).

The proportions indicated for newborns in the Frankish laws would be reversed in childhood, when the wergild for girls amounts to 200 solidi, while remaining at 600 solidi for boys (*Pactus Leges Sal.* 24.i), approximating that of adult women. Furthermore, boys were not held responsible for their actions (*Pactus Leges Sal.* 24.vii, cf. Halsall 1995: 72). The coming of age would have been set at 12 years

[67] Halsall (1995: 72) refers here to 'foetus' and includes the fact of violent abortion.
[68] The relations are of importance, not the actual amounts (Brather 2008b: 268), as they were set much lower, probably due to the peripheral and rural setting of the Alamannia.

(*Pactus Leges Sal.*) or 15 years (*Lex Rib.*), without an explicit distinction between boys and girls.

The wergild sum for harming women of child-bearing age (600 solidi, Murray 2000: 535) was three times as high as that of adult males[69], and equivalent relations can be found in the Alamannic laws (*Pactus Leges Alam.* XIV, 6 - 11: harm to a man was punishable with 160 to 240 solidi, but to a woman with twice as much (Brather 2004b)). If a pregnant woman was beaten to death, the offender would have been liable for 700 solidi (28000 denarii, Lex Sal. 24, Murray 2000: 535). Harm to old adults would have cost the offender the regular amount of 200 solidi. It is assumed that this applied to both men and women, although it is only explicitly mentioned that the wergild falls back to 200 solidi for a free woman who ceased to be able to have children (Halsall 1995: 72; Murray 2000: 535).

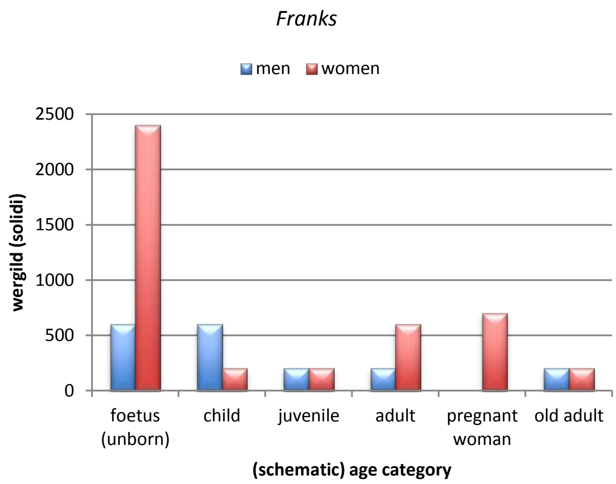


Fig. 3.1: Wergild sums defined by the *Leges Francorum*, according to schematic age categories. Data gathered from Halsall (1995: 72f.); Lohrke (2004a: 29ff.); Brather (2008b)

[69] Brather (2004b) notes that depending on the rank of a man (i.e. his proximity to the king), his wergild could range between 200 and 1800 solidi.

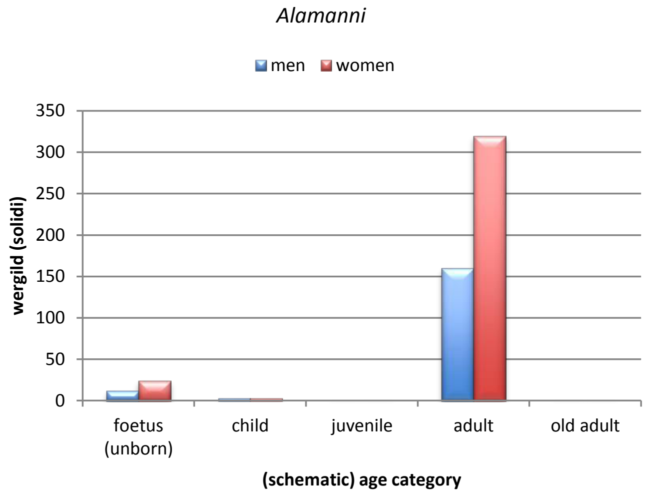


Fig. 3.2: Wergild sums defined by the *Leges Alamannorum*, according to schematic age categories. Data gathered from Halsall (1995: 72f.); Lohrke (2004a: 29ff.); Brather (2008b); Elsakkers (2008)

Comparing these indicative sums for the "value" of people, which Brather equals with "social esteem" expressed in burial, by means of wealth of burial accoutrements, he arrives at a profile for the male and female life course that suggests social importance was indeed higher during adult life (ca. 20 - 50 years), while less so at younger and older age, when burials are less wealthily endowed. Siegmund (1998b) merely mentions that weaponry and brooches would most frequently occur in burials of adult and mature individuals and therefore mark these age categories. He assumes that a higher risk for a woman dying at childbirth (i.e. in child-bearing age) equals a higher compensation, which is expressed in the burial wealth. As burials of younger women are often comparatively wealthy, the typical age at marriage and childbirth can be set at ca. 25 - 30 years. A similar conclusion is found by Brather who conjectures that males in the "prime" of their lives would have been head of the *familia* and therefore received wealthy burials, and continued to do so until their sons occupied this role; women would have shown wealthy burials as long as they passed away at an age that would have still meant 'potential for the future' (Brather 2004b: 33).

The finding of mostly no or few grave goods in children's graves is explained by the assumption that a very high child mortality[70] would mean an inability for families to greatly invest in all the child funerals (Brather 2008b: 269). Juvenile boys and girls would be less important to society, as they would not yet have taken over their "social roles" (Brather 2004b). Siegmund principally outlines the same inference when he describes that only few grave goods and "practically no weapons" are found in burials of neonates and young infants (0 - 6 years; Siegmund 1998b: 179), while first but rare offerings of weapons or brooches (!) occur in graves of older children (6 - 12 years) and juveniles (12 - 18 years), yet still to a much lesser extent than in adult burials[71]. He strongly ties weapons and female costume to the statement of adulthood and therefore social responsibility and standing.

There are numerous shortcomings apparent in this reconstruction of life course and social importance, the first, again, being the direct reflection of life that is sought in the legal codes. The authors disdain the fact that law codes were drawn up to name the sum of wergild for the act of violating the law (i.e. they are lists of fines for crimes committed against persons), and strictly speaking not for an individuals' worth or "value". There is no logical reason why the amount of *wergild* should be directly reflected in the wealth of burial accoutrements, considering the deceased is not buried by the person who has committed the crime but supposedly by their

[70] It has been suggested that child mortality in the early medieval period ranges between 45 - 60%, with neonates and infants being only scarcely represented in cemeteries of that period (Siegmund 1998b: 179).

[71] "[…] for example, we seldom find weapons in graves of younger boys or male youths. Usually, these graves contain only arrow-heads and, in some exceptional cases, two types of weapons, i.e. a seax or spear in addition to arrow-heads." (Siegmund 1998: 179)

own kin. With regard to the grave goods themselves, besides readily accepting them as true reflections of the individuals' gender, Brather infers that Christlein's 'quality groups' can be consulted to determine the rank of an adult individual, however, not of a subadult, a young or an old adult (Brather 2008b), herewith attempting to categorise males and females into ranking groups with the grave good assemblage as the paramount determinant. He contradicts this, however, by acknowledging that age and sex would be more important to the nature of the burial assemblage than social rank. Thus, social roles, depending on these two factors, are reflected (Brather 2004b: 30; 2008a: 159).

Siegmund proceeds similarly by assuming relatively wealthily endowed graves for women of child-bearing age considering the high amounts of wergild listed as compensation (Siegmund 1998b: 180). Both researchers argue that, overall, the wealth of the grave good assemblage is more important to the reconstruction of stages of social age than the presence (and, supposedly, meaning) of single objects, with the exception of the functional category "weaponry" (as, for instance, applied by Kokkotidis (1999)) and certain items of female costume (cf. App. 2, Table 1) which, due to their assigned gendered nature, can indicate the social age (within a category) of an individual (e.g. Brather 2004b; 2009). A potential differentiation between functional and symbolic aspects of (gendered) grave goods, which may vary or change from society to society and / or time (e.g. Arnold 2008), is not considered, nor the fact that the character of grave good assemblages reportedly changed over time (cf. for instance Steuer 2004). Brather does acknowledge these notions at a later point (Brather *et al.* 2009: 41), but mutes evident local differences by declaring that local audiences present at the funerals would have entailed local variations.

Much of the current argumentation regarding Alamannic lives and social roles of males and females within society is flawed, as it is, not least, fraught with modern preconceived ideas. To name only one example, if the loss of a newborn girl would have been such a great devastation for a family, given they would have lost a female family member to marry off and secure their societal standing (Brather 2004b; he even suggests a girl could have only been married off once), this does not explain the great fluctuation in the wergild sums assigned to females, as opposed to males, considering the loss of a girl at any age until marriage would have meant a huge loss of 'social potential'. Returning to the aforementioned differing sums for newborn boys and girls, the suggested models fail to consider that these sums (and their ratios) were only introduced into much later redaction of the law codes; thus, if one was to reconstruct life course and social importance from these in conjunction with the burial evidence, patterns for the social significance of males and females may look very different (Fig. 3.3 for redactions of the Frankish law codes, and Fig. 3.4 for redactions of the Alamannic *Leges*):

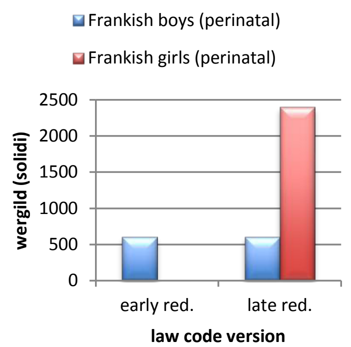


Fig. 3.3: Proportions of wergild sums for stillborn / newborn children in earlier and later redactions of the *Leges Francorum*

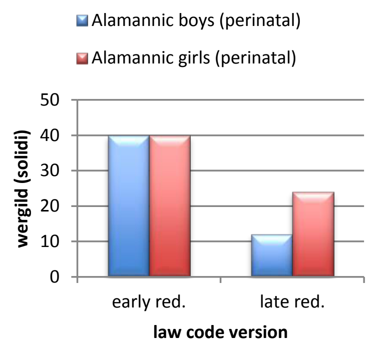


Fig. 3.4: Proportions of wergild sums for stillborn / newborn children in earlier and later redactions of the *Leges Alamannorum*

In the light of all these indications, it will be of great interest to explore the Alamannic life course with all its implications for male and female social relationships through the burial evidence, i.e. the mode of burial, grave accoutrements, as well as skeletal indicators (not only age and sex, but also health and activity markers) as defining the identities of the Alamanni in two societies.

3.2.4 The inextricability of identities - Alamannic status and the burial evidence

Status identity and the social persona

Status identity is inherent to and influenced by all the identities described above - sex and gender, age and ethnicity - as well as by the societal conditions within which an individual moves, and hardly comprehensible unless the combination of all available data, archaeological and anthropological, is considered, given that the presence of absence of grave goods alone may be linked to the extent of social competition and not necessarily the individual's status or that of its family, therefore presenting a deficient picture. Clark and Neeley (1987: 121) state that

> *"...the social persona of an individual is the sum total of the statuses occupied by that individual up until the time of death - in other words, a composite social identity."*

An individual assumes multiple statuses in his / her life, not only across the life course, but also at any given point in time, depending in which relationship it is seen. For instance, a woman might be a leader, mother, farmer, a married woman - all, or any of these identities might be symbolized in material or non-material form during her funerary rites, the material culture hereby indicating and communicating the social and personal identities of the individual (Gilchrist 1994: 44; Sánchez Romero 2008).

A suitable example with regard to the question of status and social identity when considering Alamannic social structure is the question whether in an open ranked society, status was acquired or given by birth, thus whether the grave goods do indeed reflect an individual's achieved status (Effros 2003). If we assume, judging from the child burials endowed with items of weaponry (or more lavish ones in relation to others), that even in an open ranked society, a child carried the status of its parents, or either the father or mother or, effectively, its *familia* in the community, but lost it at a certain point to either continue in the 'status tradition' by its own achievements or to assume a higher or lower status of its own, we have to assume a distinctive stage in the age course, possibly connected with a rite of passage of some kind. However, again, we have to consider the fact that the passing away of a child may have had such an effect on the bereaved that the burial wealth reflected this grief, i.e. the endowment of a child's grave with (symbolic) weaponry may have been connected with the grief upon the loss of an individual, and with the expectations the *familia* had for this child. Thus, the question remains whether (high) status relates to children up to a certain age and 'ebbs' away as soon as they reach a certain age when they are considered to be responsible and fit to fulfil certain demands that come with a certain status. Children in Alamannic cemeteries have to be looked at in relation to adults, and the variable of their age identity analysed in relation to those of other social variables (Fahlander and Oestigaard 2008).

What we see in the burial is the individual contextualized within its community. The burial data show the social persona and the social unit an individual acts in, lives in, dies in (Goodenough 1965 ; Geary 1983). Identities are nested, i.e. they operate on different levels and their aspects are almost inseparably intertwined, which entails that for a comprehensive interpretation of the social significance of an individual within its community, all aspects of the '*social persona*' have to be combined and contextualized in order to arrive at a satisfactory interpretation of life course and social organisation. To some extent, the formation and visibility of social identities is based on decisions, i.e. on what the individual attempts to be and to demonstrate outwards, as well as on the agency of the group he / she lives in. This means that we not only have to consider the fact that all social identities develop, progress and act within power relations (Hockey and James 2003: 17), but also that the burial evidence essentially illustrates self-presentation as well as perception through others. These factors describe the '*social space*' (Halsall 1996) a person lives - and dies - in and which in its definition has to be approached by eventually combining all suggestions of social identities and the functioning of a society.

Recalling the issues met when examining gender and age identity in correlation with grave goods, they lend themselves to being good examples of presenting interrelations of these identities, acting towards the social significance of an individual. Gender is determined by biological sex and entwined with life cycle components in the following way: during childhood, gender may be possibly male or female, during adulthood, male or female, and during old age, possible male or female again (Lesick 1997). The issue can be exemplified by means of grave good patterns detected by Gowland (2006) and Lucy (1998: 43ff.) in early Anglo-Saxon cemeteries which resemble in great detail those found in Northern Gaul (Halsall 1996): The very young and the very old are endowed with far fewer grave goods than the rest of the cemetery population, while also presenting the greatest proportion of gender neutral burial assemblages. It might be inferred that either we are dealing with low status graves, something that is unfortunately rather often assumed in Alamannic archaeology, or that in fact gender was not of importance yet or, respectively, any more, implying a shift of social significance of an individual within the society around a certain age (Halsall 1996), coinciding with the correlative expression of a more or less marked gender identity. This would reflect back on the consideration that the death of a young woman, for instance, would possibly have caused greater ruptures in social relationships which are indicated in the burial, but the question emerges whether this would then be seen in graves of individuals of all statuses, with grave goods of different gradations indicating a certain value to the deceased or those who bury the dead, rather than, in modern views, distinctly precious items[72].

An interesting aspect regarding a differential meaning of sex and gender, age, status and the framework of the *familia* presents the issue of wealthy female burials (cf. Chapter 3.2.2): Härke (1997a: 135) quotes a hypothesis by Jørgensen (1987), suggesting that because *familiae* expressed their status in the burial of the first deceased member of the heads of this *familia,* the generally lower life expectancy

[72] Did, in general, the inclusion of precious items depend on the social standing of the deceased and his *familia*, i.e. would it been less of a "loss" to wealthy families to endow their deceased with precious items, while in families of lower social standing, few valuables, if any, had to be passed down a few generations? Little is known about inheritance patterns especially for the pre-Frankish Alamanni, and an answer to this question unfortunately lies outside the scope of this study.

of females in the early medieval period resulted in the observed preponderance of wealthy female burials. While it is interesting that despite a general rise in female life expectancy in later periods, this gender differentiation in burial persists, with regard to the centuries in focus, this might be a possible lead to explore wealthy female burials and social identities in Alamannic cemeteries.

Altogether, it is highly beneficial to the understanding of Alamannic societies to explore age-related life cycles with regard to womanhood or manhood and their respective implicit meanings for status within their society. The aforementioned differences in items of equipment and dress in Merovingian burials suggest a gendered life course, if they apply equally to the Alamanni. The male grave good assemblage has always been interpreted in terms of social stratification and status (cf. Chapter 2.3.1), making men part of a hierarchical, vertically structured world concerned with warfare and roaming (Hakenbeck 2011). Therefore, the topic of Alamannic “warriors” and the weapon burial rite offers an excellent example to such enquiry and for the complex fabric of social identities in the archaeological context, as warriorhood does not only combine multiple aspects of identity (e.g. age, gender and status), but it can be considered as a secondary identity in itself (Vandkilde 2006c). It can be a phase in the life course of an individual (irreversible time, as not recurrent), it can be institutionalized (reversible time, as it can assume a pattern of re-occurrence), or it can be acted out in an individual’s daily life and activities (durée; reversible time), all possible in their own right but not mutually exclusive (Vandkilde (2006c: 396), referring to Giddens (1984: 35)). While warriorhood as part of the life cycle may be traced in the life course approach, the latter two factors can be potentially explored by the combination of an analysis of the burial components as well as the skeletal data on patterns of health and activity; thus, the social identity of warriorhood, created and cultured by “warfare as a social action” (Vandkilde 2006c: 404), offers multiple leads to its investigation.

3.3 Social status, biological status and burial evidence

3.3.1 Social versus biological status: Modes of evidence

Undoubtedly, material culture, seen as a form of “non-verbal communication through the representation of ideas” (Parker Pearson 1982: 100) and an expression of potentially both an individual’s social position at the time of its death and a demonstration of social ties displayed by the bereaved, constitutes one of the most important aspects in the attempt to reconstruct the mechanisms of a society. However, as indicated before, what is recovered from the grave furnishing (following the account assembled by Williams (2006a: 38f.)) is subject to:

a) *preservation*: Depending on the artefact, the survival in the grave is variable. For instance, while an identical type of vessel may be recovered, the contents may have differed and provided disparate information in the funerary rite. The quality of textiles may have differed, though held together by a similar type of fibula - the indication of belonging to different status groups via an important dress component is therefore lost to the archaeological interpretation.

b) *regional and chronological differences and changes*: Factors such as inheritance customs or overall the economic availability of material items can influence the presence of certain objects in the burial and point to local distinctiveness; changes in fashion, particularly with regard to dress components, can influence the interpretation of gendered grave goods and their significance for identifiable rites of passage.

c) *symbolism*: The significance of religion, wider “cosmological themes” (cf. Shanks and Tilley 1982) or memory and mnemonic practices (cf. Metcalf and Huntington 1991: 61ff.; Williams 2003 ; 2006b), all of which influence the funerary ritual and may be conveyed via the grave good assemblage, is not clear with regard to the Alamanni.

d) *context*: Social and symbolic meanings of artefacts are closely interrelated with the funerary context (e.g. Härke 1997b) as well as with the audience of the funerary rite (Halsall 2003a). Moreover, in the interpretation of the burial furnishing, the symbolic context of an object is only too often transformed into a functional one[73] (Halsall 1998a), confounding the evidence.

e) *agency of the bereaved*: Since “the dead do not bury themselves” (Parker Pearson 2001: 84), the burial strongly reflect the actions, identities and ideas of the living; hence the deceased’s body may have been prepared, dressed and endowed with objects according to the characterization wished to be associated with him as an ancestor (Theuws 2009), his identity in life altered in death (e.g. Pader 1982). Bazelmans (1999) even speaks of a deconstruction of the individual at death.

[73] A poignant example is provided by Theuws (2009: 294): “Worse is still the drawing of the 6th-century kitchen of the ‘chief of Krefeld-Gellep’, where the grave goods have been taken out of the symbolic context of the burial rite and have been placed - functionally - in his kitchen. Obviously just returned from a day’s work, the chief can be seen roasting a pig (what an appetite for a single (?) man: there is only one table setting.), while being served by a man. The caption reads: ‘Der Herr von Krefeld-Gellep Grab 1782 am häuslichen Herd’ (Wieczorek *et al.* 1997: 669).”

f) *ideology*, i.e., to reiterate, the deposition of grave goods as ritual act and the burial in itself as ritual display.

Adding to that is the notion that the analysis of ranked societies is an especially complex and delicate matter. The analysis of Alamannic cemeteries to this date clearly demonstrates how the sole interpretation of burial practice without a close consideration of the biological remains leads to a dead-end and even to some questionable archaeological and historical interpretations regarding Alamannic culture and society. Not only do we encounter differences in burial practices certainly brought about by ethnic origins and composition of the Alamanni, but also regional as well as environmental differences which influenced the archaeological evidence presented in the graves, for instance with regard to the different characters in terms of economy, environment and habitat (Schutkowski 2000) of settlements such as Pleidelsheim and Neresheim. Regional differences may be visible in material culture and burial practices; regional and environmental differences, however, are evident in the skeletal evidence, as the settings individuals live in influence their health, their diet, as well as shape the conditions of physical stress and activity. The environment adds to the creation of a local society by generating, for instance, certain divisions of labour or, potentially, defining social age categories by the requirements of daily life.

If lifestyle is reflected in the burial (cf. Chapter 2.3.2), so are patterns of health and activity. Biological information is closely intertwined with cultural factors, as, for example, the access to certain foods and hence elements of diet and nutrition, or the exposure to physical stress, all of which influence the health status of an individual, are influenced by and related to factors such as social status or roles within a society (Robb *et al.* 2001; cf., for instance, Gravlee 2009). It is of great importance to focus on the combined evidence from the mortuary context, including the human remains, to construct a picture of Alamannic social complexities, identities and roles (cf. Crawford 2011). It is the connection of both bodies of evidence that leads to conclusions about how people lived, died and acted within their social environment.

Drawing upon an anthropological approach to archaeological questions is something that is often demanded in studies dealing with the archaeological, historical and social interpretation of the Alamanni (e.g. explicitly by Siegmund (1998b: 178): “So the discussion seems to be at a deadlock: [...] archaeological research alone cannot verify or reject any of these proposals [...] physical anthropology is scarcely considered.“; cf. also, for instance, Chapman 1987). Most often, however, the implementation fails due to the irreconcilability of interests and dearth of mutual acknowledgement, but also lack of collaboration of scholars in the fields of history, archaeology and anthropology[74]. Especially with regard to a population such as the Alamanni, the analysis of grave goods, even in connection with a more comprehensive cemetery analysis, does not suffice. It is essential to correlate funerary with skeletal data, beyond the constituents of age and sex, as the skeletal data are not modified by ritual, only by life itself - the skeleton is the “physical evidence of the funerary treatment” (Knüsel and Ripley 2000: 187). Juxtaposing the physical with the social body (Rega 1997 ; Knüsel 2002) renders a tracing of individual’s life histories and population’s social and physical make-up,

[74] Recent research does move forward in this aspect, particularly with regard to the relevance of questions asked, however, the departure from old interpretational models and conceptions about Alamannic social structure seems very difficult, as does the relinquishing of holding the fort for one discipline while subordinating the other. The use of palaeodemographic data is paramount, for “the rest” (lifestyle, occupation, health, other facets of identity), it is reverted back to solely archaeological information.

providing a source of information that can be related to the grave good patterns and mortuary practices we observe in order to arrive at a well-informed approach to lives, identities and social complexities within Alamannic society. As Vandkilde describes fittingly,

> *"Social identity is (...) produced and reproduced by human actions and discourse, and the human body is the medium through which identification is enacted and signified."* (2006c: 935)

The interrelations between social and biological status are sought to be deciphered (cf., for instance, Robb *et al.* 2001) by analysing the funerary data and skeletal data in conjunction, the people, as biological and social individuals, and therefore the nature of their society can be better understood. It might seem a difficult task to establish status in a skeleton, as a direct biological analogy to status is not given. In a society that consists of open ranks rather than fixed social strata or classes and where social position was not hereditary but temporary, how does this reflect in the bioanthropological record? It can be assumed that the more stratified a society, the more social groups would have differed in lifestyle, i.e. they would exhibit differences in patterns of health, physical stress or activity. If a cemetery population demonstrates a high degree of homogeneity regarding those skeletal patterns, this might indicate low levels (or even the complete absence) of stratification in the living population (Robb *et al.* 2001).

The concept of an open ranked society implies possibilities of various states of social rank an individual may have held during its lifetime, thus leading to the question whether skeletal biology of these people's remains could offer a more comprehensive insight into the life course than a mere analysis of material culture.

Whether the patterns of status hierarchy supposedly reflected in grave goods and context can be observed in the skeletal material remains to be seen, but again the accurate age and sex determination of individuals already significantly enhances the respective interpretations. While the burial record may offer information on the status and social significance of an individual towards the end of its life as well as of the bereaved, bioanthropological analysis of an individual can provide information on those circumstances which accompanied and, possibly, defined the individual during its life course, by presenting differential patterns of skeletal biology (e.g. stature), health and activity-related skeletal changes, as well as age and sex with regard to burial, i.e. body position, grave type, and the archaeological material record (i.e. number and variety of grave goods, differences in the burial rite within and between cemeteries as well as changes with time). It is of interest whether grave goods, their gradations and status indications as read in the funerary data correlate with recognisable differences in the skeletal evidence that describe the living conditions (Robb *et al.* 2001). Can we skeletally distinguish a high status group, or indeed any social group, in the Alamannic cemeteries that is suggested by the burial context?

As described in Chapter 3.2.2, a determination of biological sex, as opposed to gender as expressed in the grave goods, can allow an identification of changes in social structure over time (Knüsel and Ripley 2000). Gender identities are complex, but a successful approach is found if we combine the aspect of gender (via material culture) with the one of biological sex, which in many cases is not determined anthropologically but archaeologically, the inherent problem being obvious - we are looking at gender only, not at biological sex. It has to be noted that biological sex, however, is on no account fixed, due to the sexual dimorphism in the skeleton. A good example provides the case of "Warrior C" in Grave 3 in the Alamannic cemetery of Niederstotzingen (Creel 1967 ; Paulsen 1967 ; Gut 2010): The individual was described as having very "gracile bones" and thus rather resembling a female, however, as the grave goods in this triple burial (!) indicate archaeological males, this individual was simply identified as a "very gracile warrior" (Paulsen 1967). While the biological sex of this individual is still disputed (Gut 2010; *pers. comm.* J. Wahl 2011), this example illustrates the fallacies of sex determination through the grave goods; they do not necessarily have to be linked with a man's or woman's gender nor physical roles, something that can be potentially traced in certain cases by the analysis of activity markers, described forthwith.

With regard to gender and activity, the division of labour according to gender is widespread in societies (Ausenda 1998: 402). The question is whether we find sites in geographical contexts such as at Neresheim at variance to those like Pleidelsheim (cf. Chapters 2.1.2 and 4.1), bearing in mind that in an environment such as the early medieval countryside, the chores of daily life were supposedly efficiently divided across all members of society, whereas in a settlement that was comparatively more involved in trade (albeit still an agricultural society) and, subsequently, more involved in the manufacturing of materials, for instance, gender roles may have changed or shown different patterns. The development of social distinctions among groups is very much influenced by such conditions as, in one context, women may have carried out the same physical work as men or been actively involved in the production process, similarly to what is still the case in modern rural societies, whereas in another context, this became increasingly obsolete and resulted in the creation of different social spaces for the women.

The determination of biological age adds to a better understanding of social patterns by defining age categories for the population under study and following the social role of the life cycle by correlating grave goods and burial context with the biological age of individuals. If stages of age identity are in fact interpretable in the present cemetery contexts, it should be possible to differentiate age thresholds, possibly even visible across all social groups of a cemetery population. These interpretations of social age are crucial to the interpretation of social mechanisms in general, as the examples listed in Chapter 3.2.3 have demonstrated. In connection with life course studies, the consideration of data on skeletal health, physical stress and activity-related alterations of the skeleton can be applied for a comprehensive interpretation of male and female identities. So have trauma patterns been explored in comparison and integration with age categories, with the question whether certain patterns would be either specific to a gender and / or an age category (Vandkilde 2006c ; Glencross 2011).

The example of child burials containing items of weaponry is cited again in a wider context. An analysis of biological age has implications for the establishment of age categories, but also for the use of weaponry (symbolic vs. potential; actual and functional value). This permits assessment of the value of children and the meanings of certain concepts such as *familia* and status representation - are grave goods indicative of a “social value“ of age, and are patterns visible for different ranks of society? In the Alamannic cemetery of Kirchheim a. R. (Neuffer-Müller

1983), arrowheads were found in children's graves (Jørgensen *et al.* 1997). Synthesising the factors of age, status and physical anthropological evidence, it is assumed that this part of weaponry was an indicator of status, as a child of that age could not have drawn a bow that would fit the type of arrowheads found (Jørgensen *et al.* 1997).

Regarding the issue of adult males, Alamannic 'warriors', usually classified as members of higher status, Härke (1997c: 120) points out the advantages skeletal analysis has in investigating especially this matter. In his studies on weapon burials in Anglo-Saxon cemeteries (Härke 1990; 1992; 1997c) he found that weapon burial is positively correlated with the male sex as well as stature (Härke 1990); however, a correlation lacks regarding weapon endowment and age-at-death, physical "appearance", health or trauma stemming from battle-related conflict - in fact, it seem to have been those who were *not* fit for active battle who were buried with weaponry, while those individuals who were involved with some kind of fighting were buried without such armament, i.e. the absence of certain expected correlations is of significance as well. This may either emphasize how little weapon burials had to do with actual "warriors", or it might indicate that only families of certain status buried their men with weapons, regardless of the individual's ability to fight. The positive correlation with stature may have some significance towards better living conditions during infancy and childhood (Larsen 1997), in turn associated with status[75] (Mays *in prep.*). It all reflects back onto the attempts at classifying Merovingian graves (as illustrated in Chapter 2.3.1), where the vast

[75] Both Straub (1956) and Czarnetzki *et al.* (1983: 9ff.; 24ff.) suggested that stature differences according to social rank could be found in selected cemeteries from early medieval southwest Germany, with high status individuals (nobility) being taller on average than the free and unfree. Huber (1967) meant to discern the tallest males among the "heavily armed" and the shortest among the "unarmed". However, the status ascriptions rely entirely on deductions from the material record and are subject to the problems described throughout in Chapters 2 and 3 of this study.

majority of graves falls into the “second stratum“ of burials, i.e. the well-endowed weapon graves (Steuer 1982a: 312ff.). The question whether weapon grave goods correlate in any way with anthropologically recognizable differentiations of individuals or burial groups has been already posed by several researchers (e.g. Wahl *et al.* 1997), but was usually not taken beyond the correlation of weapon-related trauma and weapon endowment. The exploration of physical attributes of individuals buried in “weapon graves” reveals the great benefits of biological indicators of stress and activity on the skeleton, as the aspect of warrior identity in all its facets can be evaluated. Härke’s research has resulted in the identification of weapon endowment in male burials as describing the “concept of warrior”, rather than the active warrior, hence it will be of great interest whether this concept with regard to the Alamannic “warriors”, whether as a lifestyle or a social role (Knüsel 2011: 222) can be explored bioarchaeologically, in a detailed analysis and combination of material and physical evidence, as “the only truly individual materialities left in a grave are the deceased’s own bones.” (Fahlander and Oestigaard 2008: 11).

3.3.2 An active life: Indications from patterns of skeletal health and activity

Indicators of lives lived - Patterns of skeletal health

Considering the fact that bodies are not static but subject to constant change and development over a lifetime, influenced by the biological determinants of sex and age but also by the conditions an individual grows up in and experiences it lives through, the social perceptions of the body, influenced by an individual’s place in society, are just as changing and intertwined with each other (Crawford 2011). Palaeopathological analysis can provide insight into disease patterns, diet and nutritional status, as well as developmental and environmental stress of an individual and on a population level, which ultimately form a substantial part of the definition of a society and the individuals shaping it. Albeit analysed separately, the markers of skeletal health and stress as well as activity detected in the skeleton are best comprehended and interpreted in conjunction, as they form a "mosaic of responses" (Robb *et al.* 2001: 214) to life.

While a palaeopathological analysis of Alamannic skeletons from Horb-Altheim and comparative samples was conducted within a bioarchaeological study by Z. Obertová (2008), T. Jakob (2009) has provided the, to date, most comprehensive palaeopathological analysis of early medieval Alamannic skeletal remains from Southwestern Germany. Her comparative study with early medieval cemeteries from Britain lists a detailed account on the palaeopathological analyses possible on the material, including the observation of dental disease, joint disease, trauma, infectious and non-specific infectious disease, which are largely taken up also in this study. Although the observation of dental pathology is not excluded, given that its consideration can provide important indicators of diet, health, subsistence and, ultimately, status (Lukacs 1989 ; Lukacs and Pal 1993 ; Hillson 2008), for the present study, the focus on stress- and activity-related changes to the skeleton, effected by physiological stress, ageing or mechanical stress, proves as especially interesting. Individuals of differing social status may exhibit different indicators of stress in their skeleton, including traces of metabolic deficiencies, dietary marks, markers of behavioural or habitual stress or indications for certain activities (Jurmain 1999 ;

Pechenkina and Delgado 2006), and special attention is drawn to gender-specific differences (Sofaer Deverenski 2000b) as well as to disparities between subadults and adults (Buzon 2011).

Cribra orbitalia and dental linear enamel hypoplasia are early onset skeletal markers that can be read as indicators of subadult health (Goodman and Armelagos 1985 ; Ortner 2003 ; Lewis 2007: 134ff.; Obertová and Thurzo 2008) and therefore provide indications for non-specific physiological childhood stress. Cribra orbitalia, with its etiology debated (e.g. Wapler *et al.* 2004 ; Walker *et al.* 2009) but generally associated with iron deficiency in the blood (Ortner 2003), affects the orbital roofs by a thinning of the cortical surface and producing a sieve-like porosity or pitting (Ortner 2003; Aufderheide and Rodriguez-Martín 1998). It may result from multiple conditions during growth, such as malnutrition, infectious disease, scurvy, or types of anemia (Hengen 1971 ; Stuart Macadam 1989 ; Stuart-Macadam 1991a). Hypoplastic developmental defects in the tooth enamel are considered the result of growth interruptions that may be caused by various factors, for instance malnutrition, episodes of infectious disease or physical stress during dental development in general (Goodman *et al.* 1984 ; Goodman and Armelagos 1985 ; Goodman and Rose 1990 ; 1991 ; Hillson 2008 ; Ogden 2008a).

In previous anthropological analyses, traces of non-specific infectious disease, particularly periostitis, have been considered direct indicators for habitual activity of the affected individual (for instance, horseback riding as a cause for tibial periostitis (Wahl and Kokabi 1988)), with apparently relatively high prevalence rates in early medieval populations[76], neglecting the fact that periosteal lesions form an inflammatory response that can result from a variety of causes, such as infectious disease, trauma or metabolic conditions (Aufderheide and Rodriguez-Martín 1998 ; Ortner 2003 ; Weston 2008; 2011). Nonetheless, the presence of non-specific infections can offer revealing insights into aspects such as environmental, nutritional or sanitary conditions (Kelley 1989) and reflect health differences on a population level (Larsen 1997: 84), even though the identification of the underlying process is usually not identifiable from the skeletal material (Ortner 2003). Tibial periostitis is one of various pathological reactions in the form of periosteal deposition of new bone under an inflamed periosteum following a infectious disease or injury (Ortner 2003), most commonly found on the tibial shaft (Robb *et al.* 2001). Due to the possible observation of unilateral (i.e. localized) or bilateral (i.e. diffuse) systemic occurrence, it is a useful indicator for a distinction of the periostitis being sign for either localized trauma by repetitive stress or an infectious disease process. Another very common indicator for stress and a non-specific inflammatory response is maxillary sinusitis, forming in the maxillary antrum and most commonly caused by respiratory infections, invasive dental abscesses or allergies (Boocock *et al.* 1995 ; Lewis *et al.* 1995 ; Roberts 2007).

Trauma lesions are most frequently due to violent or accidental impact, thus permitting the interpretation of interpersonal violence (e.g. Walker 1989 ; Jurmain 2001 ; Armit 2011) or heightened susceptibility due to heavy physical labour (Judd

[76] This assumption can be neglected, however, as the present analysis and a subsequent comparison with previous observations of tibial periostitis has shown that taphonomic damage to the tibial shaft was, in fact, often mistaken for tibial periostitis.

and Roberts 1999) and, subsequently, to conclude on possible age-, gender- or status-related differences in a population (Judd and Redfern 2011), as well as on the occurrence of warfare (Knüsel 2005) and warriorhood (Judd and Redfern 2011). Daily life and physical work expose the individual to the risk of a variety of traumatic conditions, with certain injuries showing characteristic patterns; for instance, a *Colles' fracture* on the distal radius usually indicates the attempt to brace against a fall, a *parry fracture* located on radius and/ or ulna points to the defense against a frontal attack (Herrmann *et al.* 1990: 125; cf. also Judd 2008). Compression fractures of the femoral neck or the lumbar vertebral bodies can indicate a fall from a certain height, while a spiral fracture of the tibia may result from the turning movement of the body with the foot firmly placed on the ground (Lovell 2008). Trauma to the cranium can indicate interpersonal violence by sharp or blunt force, but also injuries resulting from falls or other accidents (Herrmann *et al.* 1990: 117ff.). The evidence of healed trauma and its healing patterns often point to a high degree of medical knowledge and care in Alamannic populations (Wahl *et al.* 1997).

Trauma also includes symptoms of repetitive stress. One example are avulsion fractures, i.e., for instance, a fracture of the lower cervical or upper thoracic spinous process due to mechanical stress, e.g. a so-called 'clay shoveller's fracture' (Knüsel *et al.* 1996 ; Jordana *et al.* 2006), or avulsion fractures of the humeral medial epicondyle due to severe strain on the flexor muscles during childhood or early adolescence (Resnick and Niwayama 1988: 2976; Knüsel 2011). Another case is the diagnosis of *os acromiale*, a condition which is associated with the incomplete ossification of the acromial process of the scapula and presumably caused by severe stress on the rotator cuff muscles, either uni- or bilaterally[77] (Stirland 1987 ; Knüsel 2000b). This condition is often described for the skeletal remains of individuals involved in early weapon and archery training (Knüsel 2000a ; Stirland 2001), however, such bony responses to particular weapon use are most likely accompanied by additional skeletal responses to stress, such as, for instance, hypertrophy of certain skeletal elements in shoulder and arm (Knüsel 2000a ; Rhodes and Knüsel 2005).

Indicators of degenerative joint disease, in particular osteoarthritis, but also vertebral conditions such as Schmorl's nodes, spondylosis, spondylolysis (Bridges 1989b ; Fibiger and Knüsel 2005) or the ossification of ligaments (Ortner 2003), are often associated with the performance of heavy physical activity over the course of an individual's lifetime, with particular increase with advancing years (Jurmain 1977 ; 1999; Maat *et al.* 1995 ; Stirland and Waldron 1997 ; Molnar *et al.* 2009). However, it has to be noted that many physically active individuals do not display degenerative changes such as osteoarthritis, even in old age (Knüsel 2000b), so a causative correlation is not always to be expected. It has been suggested that in general, the upper limb and the pectoral girdle are more suitable for the investigation into activity-related stress patterns in the skeleton (Ortner 1968 ; Jurmain 1977), as factors such as weight-bearing or locomotion have greater effects on the lower limb. The observation of activity-related habitual osseous changes to the vertebral column, however, might be impeded by biological constraints (Knüsel *et al.* 1997), as the impact onto the spinal components would have to be of

[77] There is some argument as to whether this condition may have a congenital cause (Liberson 1937 ; Miles 1994).

considerable weight to be visible as occupational stress markers in the skeleton. In general, a multifactorial nature has to be assumed (i.e. age, sex, weight, nutrition, infection, hereditary factors, stress due to repeated physical activity (Larsen 1997: 162ff.)), and only a joint consideration of these factors can provide indications of a differentiation of mechanically-induced versus pathologically or degeneratively caused modifications to the skeleton. The analysis of the physical wear and tear of the joints provides an important record towards the populations' physical stress levels (Aufderheide and Rodriguez-Martín 1998).

Indicators of activity - Skeletal evidence of an active life

> *"The training of an elite male for physical fighting will have an impact on the size of the muscle attachments visible on the skeleton."* (Crawford 2011: 627)

Unfortunately, things are not quite that simple. In physical anthropology, "musculoskeletal stress markers" (hereafter: MSM), more appropriately termed "entheseal changes" (Jurmain and Villotte 2010 ; Jurmain *et al.* 2011), are argued to reflect the activity of the attaching musculature, as the performance of repetitive tasks over a long(er) period of time and the mechanical stress on muscle or muscle groups herewith associated can lead to muscle hypertrophy by increased blood flow, stimulation of bone-forming cells, and the osseous alteration of muscle attachment sites (Wolff 1892 ; Hoyte and Enlow 1966 ; Woo *et al.* 1981 ; Kennedy 1989 ; Lai and Lovell 1992 ; Larsen 1997 ; 2002). Hence, their study and the subsequent reconstruction of habitual activities is an important concern in bioarchaeological studies (Knüsel 2000b). The skeletal responses to habitual activity include morphological changes such as supernumerary facets, degenerative joint disease as well as entheseal changes (Robb 1994 ; Capasso *et al.* 1999 ; Knüsel 2000b), the latter focussing on the observation and interpretation of changes to muscle attachment sites (Hawkey and Merbs 1995 ; Mariotti *et al.* 2004; 2007 ; Villotte 2009).

Entheses, the insertion sites of ligaments and tendons on the bone (from Greek "*ενϑεσις*", meaning "insertion"), are important anatomical structures enabling the anchorage of skeletal muscles, the dissipation of stress and distribution of load (Benjamin *et al.* 2006). They are involved in the transition of forces to generate movement and therefore subjected to mechanical loading, which triggers a response by the bone and therefore presents surface irregularities such as rough or remodelled articular surface, ridges, grooves, recognisable on the entheseal sites (Benjamin and Ralphs 1997 ; Benjamin *et al.* 2006 ; Benjamin *et al.* 2007 ; Villotte 2009). Size and morphology of the osseous response at an enthesis, however, are subject to a variety of factors including sex, age or genetic factors (Kennedy 1989; 1998 ; Stirland 1998). Two types of enthesis have to be distinguished, a fact that has been neglected in older studies (e.g. Hawkey and Merbs 1995): fibrocartilagenous entheses, located on epiphyses and apophyses of bones, and fibrous entheses, found at metaphyses and diaphyses (Benjamin and Mcgonagle 2001). Their different designation relates to the overall tissue architecture of the tendon-bone interface, which provides specific properties to the enthesis type, determining their ability to respond to stimuli (Biermann 1957 ; Knese and Biermann 1958 ; Benjamin *et al.* 1986 ; Benjamin and Ralphs 1998 ; Benjamin *et al.* 2000 ; Benjamin *et al.* 2002). While a detailed investigation on the effects of physical stress on fibrous and fibrocartilagenous entheses traceable in the human skeleton is provided by S. Villotte (cf. Villotte 2006; 2009 ; Villotte *et al.* 2010), it is of importance to this study that the observation of these two enthesis types entails a differential scope of interpretation. The histology of fibrocartilagenous entheses is well documented, and it is possible to define the appearance of a non-pathological fibrocartilagenous enthesis as well as its modification by the effects of physical stress on dry bone (e.g. Benjamin *et al.* 2006). Therefore, the scoring of these muscle attachment sites provides a comparatively reliable basis for the observation and interpretation of physical alteration through muscular stress (Havelková and Villotte 2007). Fibrous entheses present a far more complex structure, as they are characterised by pure dense fibrous connective tissue that links the tendon or ligament to the bone (e.g. Benjamin *et al.* 2006); only very little is known of their anatomy, detailed descriptions of physical alterations to their surfaces are rare for these diaphyseal insertions, the influence of confounding factors (e.g. body mass) on entheseal changes at these sites is not known, and it is assumed that they seem to be less vulnerable to overuse injuries than fibrocartilagenous entheses (Jurmain *et al.* 2011). This suggests that any observation and interpretation with regard to physical stress on these muscle attachment sites must be made and taken with caution, as the study of osseous modifications at these entheses, which are often considered in bioarchaeological studies (following the studies by Hawkey 1988 ; Hawkey and Merbs 1995), with regard to stress marker analysis is precarious.

The expression of entheseal changes that can be observed on the muscle attachment sites assumes the form of *enthesophytes*, i.e. bony outgrowths and cortical defects that occur at the enthesis (Benjamin *et al.* 2000 ; Knüsel 2000a: 113;

Mariotti *et al.* 2004; 2007). The development of enthesophytes is quite certainly positively related to age (Shaibani *et al.* 1993 ; Rogers *et al.* 1997 ; Wilczak 1998 ; Mariotti *et al.* 2004 ; Weiss 2007 ; Niinimäki 2009 ; Villotte 2009) and generally more frequent in males than in females (e.g. Robb 1998 ; Villotte 2009 ; Havelková *et al.* 2010 ; Weiss *et al.* 2012). Interestingly, despite the increase of more distinctive muscle markers being generally observed in older individuals, studies suggest that repetitive tasks commenced before the onset of physiological maturity, i.e. at an early age, have the greatest impact on morphological osseous changes (Knüsel *et al.* 1996 ; Knüsel 2000a).

Enthesophytes are usually associated with increased and potentially repetitive levels of activity (e.g. Hawkey and Merbs 1995 ; Wilczak 1998), however, they can also be related to pathological changes in individuals suffering from, for instance, seronegative spondyloarthropathy or diffuse idiopathic skeletal hyperostosis (DISH) (Resnick 2002 ; Claudepierre and Voisin 2005). Considering the similarity between enthesophytes and osteophytes forming around the articular surfaces of synovial joints in individuals with osteoarthritis (Benjamin *et al.* 2006), it has been suggested that osteophyte and enthesophyte formation are linked, both representing a skeletal response to stress[78] (Rogers *et al.* 1997). An *enthesopathy* refers to any pathological change of the enthesis (Resnick and Niwayama 1983). It is described as a painful attachment, resulting from an injury to the attachment site, and most commonly the result of tendinitis (inflammation of a traumatized tendon, Niepel and Sit'Aj 1979 ; Freemont 2002). Enthesopathies occur commonly in the elderly

[78] The underlying principle is comparable: It is likely that osteophytes develop in response to injury or disease, to modify stress placed upon synovial joints, limit potentially abnormal movement and aid the restoration of a functional joint surface (Benjamin *et al.* 2006).

and in cases of seronegative spondyloarthropathies, overuse and traumatic injuries, as well as DISH.

In the past, entheseal changes as well as activity-related physical alterations to the skeleton have been often used to infer specific activities or even craft-specializations associated with specific tasks and postures, in a more or less evidence-based interpretative approach[79] (e.g. Merbs 1983 ; Dutour 1986 ; Molleson 2008 ; Oates *et al.* 2008). This has been soundly criticized in more recent research (Jurmain 1999 ; Jurmain and Roberts 2008 ; Cardoso and Henderson 2010 ; Jurmain *et al.* 2011), as the etiology of changes to the muscle insertions is multifarious, many activities show similar patterns of muscle use, and studies of entheseal changes using known skeletal samples (i.e. in terms of age, sex and occupation) have often failed to find differences between activity groups (e.g. Cardoso and Henderson 2010; but see also Villotte 2009). Not only do we have to consider the synergistic nature of muscle groups (Stirland 1998), which makes it rather impossible to infer a specific activity from the changes to one enthesis, but the extent of influence of factors such as endurance, intensity or frequency on functional adaptation of the bones and especially on the remodeling of muscle insertions are not clear and still under investigation (Weiss 2003a ; Zumwalt 2006).

For individual cases, the combination of all palaeopathological as well as activity-related indications (e.g. articular facets (Capasso *et al.* 1999), joint modification and pathological changes associated with increased physical stress) should be

[79] One reason is also the line of argument, from “effect to cause, rather than from cause to effect” (Waldron 2011: 520). Waldron continues: “I have had it explained to me that it is alright to make the inference because in the past, there were relatively few occupations to chose from so that, presumably, this would increase the chances of getting the answer right. This too, is a gravely mistaken view, as a glance at a list of medieval occupations should make abundantly clear.”

considered jointly in order to arrive at a comprehensive picture for the "skeletal biography" of an individual. Indicators for "occupations" are very rarely, if at all, indicated in the grave goods from Alamannic cemeteries (Steuer 1973), considering the uncertainty about the symbolic connotation of many seemingly functional grave goods. The investigated activity-related changes in the Alamannic populations of Pleidelsheim and Neresheim will be interpreted in their framework of age, sex, skeletal health and activity-related patterns, rather than proposing specific activities for males and females that follow conjectural interpretations about their lifestyle - in order to arrive at a strong integrative approach for interpreting Alamannic life and social structures.

With a view towards these possibilities, the correlation between the formation of entheseal changes and the designation of individuals as "warriors" provides a particularly interesting point for investigation. Biologically, is it possible to diagnose particular distinctive osseous reactions at selected muscle attachment sites in individuals of various age groups who were buried with weaponry and thus archaeologically described as high(er) status, warfare-active individuals? To take it further, are indications present - biological manifestations such as enthesophytes - that could be caused by the use of the weapons buried with those individuals, or does this analysis support that either these kinds of weapons were of a symbolic rather than practical value, or that the examination of entheseal changes is indeed too variable and dependent on too many other factors to apply such an analysis? As to age and status identity, it will be of interest if a higher proportion of entheseal changes can be observed in particular age or burial groups, suggesting the early training in weapon use for high status boys described in Frankish and later medieval sources, and whether any distinctions in individuals in weapon burials continue to be present with increasing age.

Several studies have made use of the observation and interpretation of entheseal changes in order to reconstruct differences in patterns of activity-related skeletal alterations pointing to the sexual division of labour (Lai and Lovell 1992 ; Peterson 1998 ; 2000 ; Molnar 2006) or requirements and changes in subsistence patterns in past populations (Eshed *et al.* 2004 ; Lieverse *et al.* 2009), as well as with view to status-related distinctions and social complexity (Hawkey 1998 ; Porčić and Stefanović 2009 ; Havelková *et al.* 2010 ; Molnar 2010). On a population basis, the comprehensive analysis of activity-related markers permits investigation of whether or not distinctions in patterns can be traced within and among populations, indicating different social groups or suggesting a less broad social differentiation due to environmental requirements of daily life. Furthermore, gender-related differences in activity-patterns during the life course can be potentially outlined and integrated with the overall results of this study.

4 Materials and Methods

4.1 The skeletal samples

For this study, the skeletal remains from the cemetery sites of Pleidelsheim and Neresheim (Fig. 4.1) were analysed, by courtesy of the Landesdenkmalamt Baden-Württemberg (LDA), which permitted the transferral of the remains for anthropological analysis from the Central Archives in Rastatt (Baden-Württemberg) to the Biological Anthropology Research Centre at the University of Bradford.

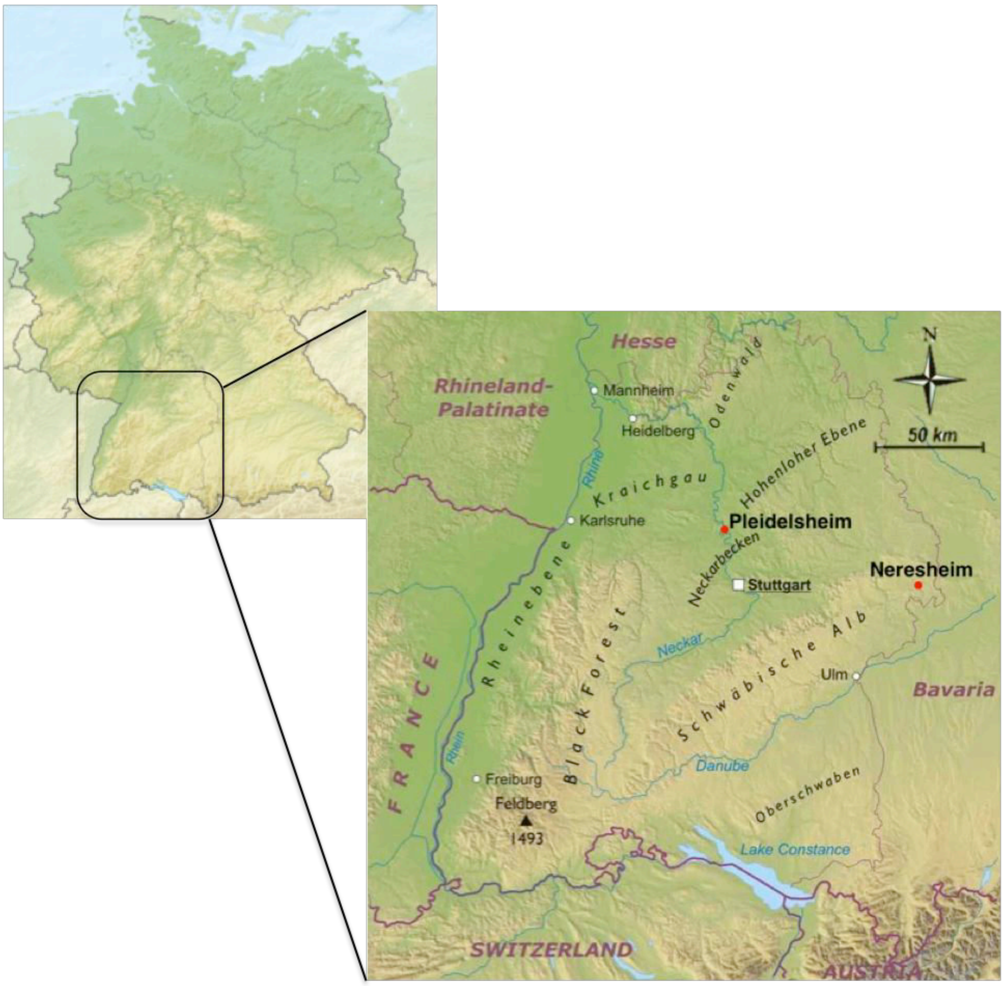


Fig. 4.1: Geographic location of Pleidelsheim and Neresheim
(Source: http://www.freeworldmaps.net/europe/germany/baden-wurttemberg.html)

4.1.1 Pleidelsheim

The Alamannic cemetery near Pleidelsheim, situated 8 km north of Ludwigsburg and overlooking the river Neckar ford (Fig. 4.1), offers an exemplary insight into the lives and deaths within a local Alamannic population during the period under study. With an occupation span from the mid-5th c. to the 7th c. AD, it forms one of the few and largest burial grounds in the middle Neckar area (Stork 1991) with occupancy from the last phase of the migration period (around 450 AD) to the height of Alamannic occupation in the late 5th c. AD and period of Frankish reign from the mid-6th c. AD onwards (Koch 2001: 353ff.). It is assumed that the cemetery (Fig. 4.2), which may hold as many as around 1000 burials, given that only around a third has been excavated (*pers. comm.* Stork 2008), expands over an area of about 90m in north - south and 130m in east - west direction (Christlein 1991: 162; Stork 1991). The associated settlement of Pleidelsheim, mentioned for the first time in 794 in the Lorscher Codex (Koch 2001: 15), is very likely not congruent with the modern town of Pleidelsheim but was possibly sited northwesterly or westerly from the cemetery (Koch 2001: 16), and placed the population of Pleidelsheim next to an important Roman trade route (Benningen - Wahlheim), the important Neckar ford between Pleidelsheim and Grossingersheim, a town which would rise to central importance during the 9th c. AD (Stork 1991), and the Neckar itself with its significance for trade and exchange. Furthermore, the people of Pleidelsheim benefitted from fertile farmland in the valley on the right side of the Neckar, and from a favourable climate with mild winters and warm summers (Koch 2001: 16).

Multiple excavation campaigns (in 1969, 1989/90, 1994 and 2003 (Stork 1991 ; 2003; Koch 2001)) revealed a row grave cemetery (Fig. 4.2) with 264 burials that were published by Koch (2001) and are subject of this study. Building works and rescue excavations resulted in the discovery of even more, albeit mostly destroyed or disturbed and neither archaeologically nor anthropologically analysable burials, which, however, brought to light material evidence that questions the archaeologically established phasing of the cemetery (*pers. comm*. Stork 2010). The skeletal remains from a further 117 burials excavated in 2003 could not be considered for this study due to the lack of archaeological and context information[80] as well as their preservational state. An inventory of the analysed burials (266 examinable indivdiduals)[81] can be found in App. 4, Table 1.

The majority of graves is oriented west-east (Fig. 4.2), with the individuals buried in supine position (with one exception, PH 132, a prone burial; cf. App. 4, Table 1) and the upper limbs positioned beside or slightly angled across the body (Koch 2001: 89ff.). The graves differ in depth and display a variety of types, including evidence of wooden coffins, shrouded burials, and tumuli; however, there is no evidence for any stone-walled graves (Koch 2001: 155). Two horse burials (PH 146 and PH 233) were found among the inhumations, dating roughly into the first half of the 6th c. AD (Koch 2001), a period for which also an above-average number of imported goods among the material evidence indicates a central importance of Pleidelsheim (Christlein 1991: 162).

[80] 90% of these graves were not intact, robbed and heavily disturbed (Stork 2003) and therefore not suitable in most parts for the present study.
[81] This is due to the occurrence of multiple individuals in some burials.

map removed for copyright

Fig. 4.2: Pleidelsheim - Plan of excavated cemetery. Modified from Stork 1991 (hatched areas = modern house and garden plots)

4.1.2 Neresheim

Located about 80km east of Stuttgart on the '*Ostalb*' (Eastern Alb district; Fig. 4.1), in a natural corridor on the slope of a small valley running north to south between the modern town of Neresheim and a 15^{th} - century cloister (Knaut 1993: 15), the Alamannic cemetery of Neresheim (Fig. 4.3) provides insight into an Alamannic community that used this burial ground from the 5^{th} c. to the 8^{th} c. AD (Knaut 1993: 187ff.) and prospered noticeably during the 6^{th} and 7^{th} centuries (Christlein 1991: 159). It is not certain whether Neresheim, which is only mentioned in 1095 AD (Knaut 1993: 19), is a continuation of the Alamannic settlement that is assumed to have been founded during the mid 5^{th} century and to have been named after the founder Narin (or Nerin; Hildebrand 2000 ; Haubrichs 2004: 90).

The people at Neresheim were subject to quite different living conditions than those at Pleidelsheim: they settled in the 'Härtsfeld' area, roughly translating to "the rocky woodless area", a region characterized by lithoidal ground unfavourable to agriculture, water shortage, comparatively low temperatures and, thus, shorter growing seasons (Hildebrand 2000). The long settlement history in this area, from the Late Neolithic onwards, is explained by the area's resources of clay and ore (Hildebrand 2000). However, there is no evidence for the Alamannic settlers to have been active in mining or clay production. The grave goods from Neresheim point to an agricultural society[82] that settled in a small basin in the inner Härtsfeld area which had been made arable for agriculture by the Romans and provided a climate somewhat more beneficial than the surrounding area (Knaut 1993: 18).

[82] As opposed to the large cemetery at Lauchheim, north - west of Neresheim; material evidence did not indicate an 'elite' or nobility with Frankish characteristics at Neresheim (Hildebrand 2000).

map removed for copyright

Fig. 4.3: Neresheim - Plan of excavated cemetery. Modified from Knaut 1993: Plate 66

Finds of Alamannic grave goods in the cemetery area had been previously described since 1872, followed by the discovery of burials from 1900 onwards (Knaut 1993: 15), mostly by building works which are responsible for gaps found within the cemetery plan. A systematic excavation of the cemetery only took place in 1975/76 (Biel 1976), revealing a row grave cemetery with burials in west - east orientation[83] (Fig. 4.3), and with a clear demarcation towards the west and south and a continuation of burials expected north- and eastwards (Knaut 1993: 22). Knaut (1993: 187) supposes that the excavations revealed about half of the entire cemetery, with around 300 more burials to be expected in addition to the 158 graves that were published by the archaeologist in 1993 and provided the burials of 164 individuals[84] that could be analysed for this study (App. 4, Table 2).

The individuals, laid to rest in supine position, were found in graves of varying depth and a width of up to 120cm, and of varying type, including wooden constructions or so-called ‘tree-trunk coffins’, but no evidence of stone-walled burials or tumulus graves was found (Knaut 1993: 26f.). Also in this cemetery, a separate horse burial was found among the inhumations, associated with a well-endowed but disturbed weapon burial (NE 44), dating to the first quarter of the 7th c. AD (Knaut 1993: 185ff.)

4.1.3 Chronological setting

In order to allow a chronological comparison of individual burials and burial groups and to identify temporal changes in the burial rite across the centuries, it was

[83] Knaut (1993: 24) points out the inaccuracy of the orientation of a few burial outlines in the cemetery plan and ascribes the slightly deviating orientation (west-south-west to east-north-east) of a group of burials in the south corner of the cemetery to their early date, around 500 AD and the beginning of the 6th century.
[84] Again, this is due to the occurrence of multiple individuals in some burials.

necessary to devise a system of combined phases, which could then be joined in order to create a system of broad chronological groups, covering about half a century each and allowing the burials to be placed into roughly the same period, permitting examination of the evidence for potential major temporal changes. Table 4.1 shows the previously described phases for the cemeteries of Pleidelsheim and Neresheim as developed by Knaut (1993) and Koch (2001)[85] (cf. Chapter 2.2.2) and the combined phases used in this study, i.e. periods I to X (cf. Inventory of analysed burials, App. 4, Tables 1 and 2). In the combined phasing (Table 4.1), periods I - III comprise the 5th c. AD and the beginning of the 6th c. AD, to the onset of Frankish rule, periods IV - VI describe the 6th c. AD from ca. 525 AD and the potential effects of socio-political change by period V or VI (broad phase D), and periods VII - X encompass the 7th c. AD.

For Pleidelsheim, Koch (2001: 353ff.) describes the first generation of settlers as well as their successors for periods I - III (SD-phases 1 - 4). Periods IV - VI (SD-phases 4/5 - 7) see the arrival of new burial customs, such as large deep burial pits and (narrow) grave chambers, and the onset of a greater variety of burial customs in terms of grave types and burial accoutrement overall, pointing to the presence of several *familiae* during the 6th c. Eventually, the cemetery is possibly extended to the south during periods VII - X (SD-phases 8 - 10; Koch 2001: 361). Due to the incompleteness of the cemetery excavations and the difficulty of a local cemetery chronology (see Chapter 2.2.2), any conclusions on potential clusters of *familiae* or

[85] Although Koch (2001) provides an extensive archaeological analysis of the burials, including typology of grave goods and a chronological attribution of burials, her results are not always congruent in their presentation and conclusion, as already remarked by other archaeologists (Brather 2004b). The phasing of the Pleidelsheim burials can only be tentative and broad.

similar groups can only be speculative. Indeed, Stork (2003) mentions that large parts of the area potentially dating into the Frankish period (6th and 7th c.) were missing from the excavations.

For Neresheim, periods I - III (Phases 1 - 3a) cover the onset of burials at this cemetery which Knaut (1993: 188ff.) places at the time of Childerich I (*c.* mid - 5th century AD). Massive grave robbing rendered the definite identification of burials from period I impossible, however, some remaining artefacts suggest their existence. Periods IV - VI (Phases 3b - 3d) comprise the era of Frankish rule, for the beginning of which (period IV) Knaut (1993: 191) describes a reduced burial intensity that picks up again in period V and VI, a time when we also notice the introduction of chamber grave types in this cemetery (Knaut 1993: 27f.). Periods VII - X (Phases 4a - 4d) encompass the 7th c. AD, with period X marking the end of this cemetery, coinciding with the decrease in grave good inclusions and the placement of cemeteries near early churches in Southern Germany (Knaut 1993: 195).

Table 4.1: Combination of phases for Pleidelsheim and Neresheim as used in this study

AD	*fixed dates*	Neresheim (Knaut 1993)	*Combined Phase (this study)*	Pleidelsheim (Koch 2001)	Broad phases
400		**Phase 1** 1^{st} half 5^{th} c. AD	**I** 1^{st} half 5^{th} c. AD	**SD-Phase 1** until ca. 460	**A** 1^{st} half 5^{th} c. AD
450	Childerich I. 457 - 481/82	**Phase 2** ca. 450 - 480/85+	**II** ca. 450 - 480	**SD-Phase 2** 460 - 480	**B** 2nd half 5^{th} c. AD
	Chlodwig I. 482 - 511		**III** ca. 480 - 525	**SD-Phase 3** 480 - 510	
500	**Frankish rule**	**Phase 3a** ca. 500 - 525/35		**SD-Phase 4** 510 - 530	
		Phase 3b 525/35 - 545/50	**IV** ca. 525 - 550	**SD-Phase 5** 530 - 555	**C** change of power (socio-political)
550		**Phase 3c** 545/50 - 565/70	**V** ca. 550 - 570	**SD-Phase 6** 555 - 580	**D** 2nd half 6^{th} c. AD
		Phase 3d 565/70 - 590/600	**VI** ca. 570 - 600	**SD-Phase 7** 580 - 600	
600		**Phase 4a** 590/600 - 620/30	**VII** ca. 600 - 620	**SD-Phase 8** 600 - 620	**E** 1^{st} half 7^{th} c. AD
		Phase 4b 620/30 - 650/60	**VIII** ca. 620 - 650	**SD-Phase 9** 620 - 650	
650		**Phase 4c** 650/60 - 680	**IX** ca. 650 - 680	**SD-Phase 10** 650 - 670	**F** 2nd half 7^{th} c. AD
		Phase 4d 680 - 700	**X** ca. 680 - 700		
700	Carolingian Empire				**G** 8^{th} c. AD
750	'Canstatt'				

4.2 Methods

An accurate estimation of age and sex, as well as a defined palaeopathological assessment of human skeletal remains is crucial to the bioarchaeological study of past populations, not only for palaeodemographic analysis, but, especially in the context of this study, for recognizing age-, gender- and status-based differences in mortuary practices, disease and diet as well as activity patterns, all of which lead to an improved understanding of living conditions and social complexity of a community. Although the skeletal remains from both sites had been previously analysed, published concisely as part of the main archaeological publications (by R. Hahn and M. Kunter for Pleidelsheim (Koch 2001: 89ff.), and R. Hahn for Neresheim (Koch 2001: 16)), the re-examination of the remains was necessary due to

- developments in anthropological methodology and the potential for advanced skeletal analysis,
- therefore, an improved age and sex assessment of all individuals with an anthropological basis,
- an extended and thorough examination of palaeopathological and musculoskeletal traits.

Due to the above reasons as well as the lack of some skeletal elements which were found to having been removed (and untraceable), others being very fragmented due to handling or the storage of the remains, and the findings of adult and subadult skeletal material which occurred in some burials and had not been previously recorded anthropologically, the re-examination of the skeletal remains resulted in a diverging and more complete record of the skeletal remains, with essential consequences for their bioarchaeological study and interpretation.

4.2.1 Anthropological analysis

A full skeletal analysis was undertaken, based on standards for osteological analysis, with a few adaptations with regard to these specific populations. Skeletal recording forms used for adult and subadult remains (available on request) include a record of burial features such as site, burial number, burial position (if known), and the level of skeletal preservation, as well as a full skeletal inventory and records of selected relevant cranial and postcranial metrics and non-metric traits, stature (adults), biological age and sex, pathological analysis, and scoring of entheseal changes (adults). If additional skeletal elements of another individual were found among the remains of a burial, an MNI was established for this grave (App. 4, Tables 1 and 2); if the remains provided enough information to assess the sex and / or age of the additional individual, especially in case of subadult remains often found commingled with those of an adult skeleton, the individual was recorded as a separate burial for this particular grave.

The results of the skeletal analysis, by different techniques drawn from multiple sources, were recorded separately and eventually combined in order to arrive at the most accurate assessment possible and to allow for an analysis of often fragmented and poorly preserved skeletal remains.

4.2.1.1 Metric analysis

Cranial and postcranial measurements were taken with an osteometric board, sliding and spreading calipers to the nearest 0.1mm after guidelines by Bräuer (1988), based on the classic measurements defined by Martin and Saller (1957) and Howells (1973). An overview of the measurements taken can be found in App. 4, Tables 5 - 8, while individual metric results can be supplied by request. The osteometric analysis of subadult skeletal remains followed Fazekas and Kosa (1978), with a choice of measurements following suggestions by Buikstra and Ubelaker (1994). A note was made if at least one landmark had to be estimated, or if pieces of fractured cranium could be held in place to allow an accurate measurement. If a pathological condition might have changed the original measurement or landmarks for the measurement, it was entered as non-recordable.

4.2.1.2 Sex assessment

Sex was determined by means of the dimorphic features of pelvis and cranium, as well as by metric formulae, and recorded as

M = male,

M? = probable male,

I = indeterminate,

F = female,

F? = probable female,

and ‘unobservable’ (ND). For the purpose of analysis of these sizable, but not large samples, probable males / probable females were grouped with males / females in this study. In cases where skeletons were preserved well enough to show sufficient indicators of sex, yet these being still ambiguous, an individual was recorded as 'indeterminate'.

Given the function of the female pelvis with regard to childbirth, pelvic morphological features are considered to be the most reliable indicators for sex determination (Cox and Mays 2000 ; White and Folkens 2000). For the visual determination of sex using pelvic morphology, standard methods as described by Phenice (1969), Bass (1995), Mays (1998), Ferembach *et al.* (1979), as well as by Bruzek (2002) were applied in order to compare the results and arrive at the most informed sex assessment possible. Considering the fragmentary nature of the material and often poor preservational state of the inferior pelvis and the ischium and pubis, the assessment of these features as well as the use of the very reliable Phenice method proved to be not applicable in many cases. The same applies to the consideration of the sacrum (Ferembach *et al.* 1979), which was one of the features assessed additionally.

Sex determination from cranial features followed the recommendations by Buikstra and Ubelaker (1994), Mays (1998), and Acsádi and Nemeskéri (1970). Although considered potentially less reliable on its own as a method for assessing biological sex due to their interdependency with factors such as robusticity or age (e.g. Walker *et al.* 1988), cranial morphological features can provide an accuracy of up to 96% (Maat *et al.* 1997) and were employed in addition to the observation of pelvic features in this study, albeit weighing less heavily in terms of accuracy. Cranial features were only considered in isolation if they were all found to be in agreement. Where possible, the degree of sexual dimorphism for cranial features was calculated following the suggestions by Ferembach *et al.* (1979) and Giles and Elliot (1963).

Long bone measurements of clavicle (Bass 1995), humerus (Suchey 1997), radius (Berrizbeitia 1989 ; Bass 1995), and femur (Black III 1978a ; Bass 1995 ; Suchey 1997), as well as scapula (Bass 1995) were assessed for sex determination in addition to the observation of morphological features, especially in cases where the material was too fragmentary to obtain a reliable sex estimation from the pelvic and / or cranial features. Furthermore, the visual assessment of morphology of the distal humerus (Falys *et al.* 2005) was found to provide reliable indication of sex in the Alamannic samples, as well being mostly in congruence with other morphological findings.

Sex assessment in sub-adults

It is generally acknowledged that sex determination in subadult skeletal remains is difficult due to minimal differences in morphological features of the skeleton prior to puberty (Fazekas and Kosa 1978), and various studies have discussed and demonstrated the potential problems in terms of reproducibility of suggested methods for sex assessment in immature remains (e.g. Molleson *et al.* 1998 ; Scheuer 2002 ; Wilson *et al.* 2008), including tooth dimensions in the deciduous dentition (Black III 1978b ; Rösing 1983), as features of sexual dimorphism vary between populations (Schutkowski 1994 ; Vlak *et al.* 2008), or due to a lack of representative documented collections (Rösing 1983 ; Molleson *et al.* 1998 ; Mays and Cox 2000). Pelvic and mandibular morphology do show evidence of some sexually distinctive traits, as reported by Weaver (1980, for perinatal infants), Schutkowski (1993), and Loth and Henneberg (2001), that can be used for determining the sex of children, with accuracy levels for females ranging between 72 - 92% and hence a little lower than for males (Schutkowski 1993 ; Sutter 2003 ; Wilson *et al.* 2008), and these traits are usually obliterated during later childhood (Reynolds 1947).

In those cases where mandible and / or pelvic bones were preserved well enough to allow for a sex assessment, the described dimorphic traits of ilium and mandible (Schutkowski 1993) were found to be distinguishable in the present samples, supported by a seriation of the remains which established this method (Schutkowski 1990 ; 1993) to work favourably for the immature skeletal remains from Pleidelsheim and Neresheim. The examination of sexual differences in tooth crown size (Ditch and Rose 1972 ; Black III 1978b ; Rösing *et al.* 1995) to support the assessment of sex of the subadult remains was applied in very few cases where teeth were present but sex from the pelvic and / or mandibular features was indeterminate, however, time constraints did not allow for applying this method, which, moreover, is considered very population-specific as well as problematic (Molleson *et al.* 1998), for all subadult remains.

4.2.1.3 Age estimation

The estimation of adult age-at-death was based on the assessment of surface degeneration of the pubic symphysis (Brooks and Suchey 1990), auricular surface of the ilium (Lovejoy *et al.* 1985 ; Buckberry and Chamberlain 2002), late fusing epiphyses (Webb and Suchey 1985 ; Buikstra and Ubelaker 1994 ; Black and Scheuer

1996 ; Scheuer and Black 2000), and, as additional means, dental attrition (Brothwell 1981 ; Lovejoy 1985) and development (Ubelaker 1989) as well as cranial suture closure (Meindl and Lovejoy 1985). As the auricular surface showed a much higher level of survival and preservation than the pubic symphysis in the present samples, the results of the two methods for age estimation from the auricular surface were assessed in combination, with the criteria as devised by Buckberry and Chamberlain (2002) proving slightly more consistent and applicable for these samples and the age assessment more expedient than the application of Lovejoy and colleagues' criteria.

While the recording of dental development as well as fusion stages of late fusing epiphyses provided a reliable distinction between adolescents, young adults and individuals over 25+ years in the Alamannic samples, the assessment of dental wear could only be indicative of very broad age categories, as a seriation regarding dental wear for the Alamannic samples, as advised by Lovejoy (1985), and a subsequent comparison with the age-at-death profiles resulting from the skeletal indicators indicated an under - aging of the two populations when using dental wear.

All of the above methods were found to be appropriate for assessing age-at-death in the samples under study. Cranial suture closure was used to provide an additional rough age estimate, considering the debate over its reliability as an age indicator (e.g. Hershkovitz *et al.* 1997). The assessment of morphological changes of the sternal rib ends, preferentially of the fourth rib (İşcan *et al.* 1984; 1985), was attempted but could not be employed due to the poor preservational state of the ribs, which made it impossible to establish an order for seriation, and of sternal rib ends. Other supporting indicators for age estimation were the observation of degenerative changes as a rough gauge, considering their interdependency with not only age, but also health and activity of an individual (Jurmain 1999), and of the ossification of thyroid cartilage (Krogman and İşcan 1986: 127 - 129). The final comparison of established age-at-death profiles for the populations of Pleidelsheim and Neresheim supports the notion of most researchers that a multifactorial approach can lead to relatively accurate and concordant results (Acsádi and Nemeskéri 1970) and helps to diminish the error rate as far as possible (Bocquet-Appel and Masset 1982).

Age estimation in sub-adults

An estimation of age-at-death of immature individuals was based on observations of dental eruption and development (Moorrees *et al.* 1963 ; Smith 1991 - developmental stages for permanent mandibular teeth), long bone length (Stloukal and Hanáková 1978)[86] as well as indicators of skeletal maturity, i.e. development and fusion of cranial bones, including the temporal bone (Weaver 1979), and epiphyseal fusion (Scheuer and Black 2000). The dentition provided the most important information, due to an often better preservation of teeth in comparison with that of skeletal elements, and to its closer correlation with chronological age as opposed to epiphyseal fusion and long bone length which can be subject to potential arrests in growth and development (Ubelaker 1989 ; Schwartz 1995). However, the assessment of maximal diaphyseal long bone length following the data established by Stloukal and Hanáková (1978), who based their study on ancient Slavonic populations, thus geographically and temporally relatively close to

[86] This method works best for an age of up to about 14 years.

the present samples, and a comparison with data provided by Maresh (1970) resulted in comparable age estimates for the subadult remains. The estimation of foetal remains as devised by Scheuer *et al.* (1980) did not apply to the remains in the samples under study. On a case-by-case basis, the most accurate age estimates possible were noted per individual, however, for the purpose of analysis, the remains were categorized into more broad subadult age categories.

4.2.1.4 Anthropological and archaeological sex and age estimations

In both cemeteries, previous descriptions of the individual's sex were based on an admixture of anthropological and archaeological assessment, with a preference for the latter if the skeletal remains were too fragmented for an estimate - and even when they were not -, and for gender-indicative grave goods surpassing anthropological indication (Knaut 1993 ; Koch 2001). As this study is based solely on anthropological sex assessment, and methods for age estimation also differ from those applied in the previous analyses, the sex and age assessments from those studies were compared to the present ones.

The comparison of sex estimates for Pleidelsheim showed that in 60 cases out of 266 (i.e. 22.6 %), the present sex determination differed from the previous analysis. This comprises 14 cases in which males were determined to be females, eight of which were children. The reverse applies to another 14 cases in which female individuals were determined to be male by Hahn (1993) and Koch (2001), of which three were children. The present study found sex to be indeterminate in 32 cases in which Hahn assigned male or female sex, of which 11 were children. The age estimates in the present study differed in 18.8% of cases from the previous analysis, i.e. in 50 out of 266 cases, age was not concordant. For Neresheim, sex determination differed only in 12.8% of cases from the previous analysis (50 cases out of 164). In seven cases, males were determined to be females, of which four were children (Hahn 1993); in another seven cases, the reverse applied, with one child among these burials. Biological sex was found to be indeterminate in seven cases in which Hahn assigned male or female sex, of which three were children. In only one case, the present age determination differed from the previous analysis. The male - female dichotomy can be explained by the use of "archaeological" sex determination, as certain types of grave goods would be considered engendered by the archaeologists and therefore were accepted to the exclusion of the anthropological sex determination.

4.2.1.5 Stature estimation methods

Numerous techniques have been developed and applied to estimate stature from skeletal remains of adults and children (e.g. Telkkä 1950 ; Trotter and Gleser 1952; 1958 ; Olivier *et al.* 1978 ; Feldesman 1992), either from complete long bones or fragmented remains (Müller 1935 ; Steele 1970). While subadult stature is not of importance for this study and was therefore decided to be left undetermined, adult stature for the examined individuals was estimated using long bone measurements of humerus, radius, femur and tibia, and regression equations provided by Pearson (1899), Breitinger (1937) (for males), Bach (1965) (for females), and Trotter (1970)(Caucasian males and females, with correction from Trotter and Gleser

1977)(Table 4.2). As stature varies between populations, this decision was based on recommendations made in previous studies which assessed populations of similar temporal and geographic setting (e.g. Obertová 2008), with the aim of comparing means of body height estimates for closest fit, as well as with consideration of the comparability with other bioarchaeological studies on Merovingian and Alamannic cemetery populations.

Table 4.2: Stature estimation formulae used in this study

	Males		
	Pearson (1899)	**Breitinger (1938)**	**Trotter (1970)**
Humerus	0.641 + 2.894*Hu ±3.3cm (H1)	83.21 + 2.715*Hu ±4.9cm (H2)	70.45 + 3.08*Hu ±4.05cm (H1)
Radius	85.925 + 3.271*Ra ±4.0cm (R1)	97.00 + 2.968*Ra ±5.4cm (R1b)	79.01 + 3.78*Ra ±4.32cm (R1)
Femur	81.306 + 1.880*Fe ±3.3cm (F1)	94.31 + 1.645*Fe ±4.8cm (F1)	61.41 + 2.38*Fe ±3.27cm (F1)
Tibia	78.664 + 2.376*Ti ±3.5cm (T1)	95.59 + 1.988*Ti ±4.7cm (T1b)	78.62 + 2.52*Ti ±3.37cm (T1)
Femur + Tibia	71.272 + 1.159*(Fe + Ti) ±3.0cm		63.29 + 1.30*(Fe + Ti) ±2.99cm
	Females		
	Pearson (1899)	**Bach (1965)**	**Trotter (1970)**
Humerus	71.475 + 2.754*Hu ±3.5cm (H1)	98.38 + 2.121*Hu ±3.9cm (H1)	57.97 + 3.36*Hu ±4.45cm (H1)
Radius	81.224 + 3.343*Ra ±4.1cm (R1)	116.89 + 1.925*Ra ±4.5cm (R1b)	54.93 + 4.74*Ra ± 4.24cm (R1)
Femur	72.844 + 1.945*Fe ±3.3cm (F1)	106.69 + 1.313*Fe ±4.1cm (F1)	54.10 + 2.47*Fe ±3.72cm (F1)
Tibia	74.774 + 2.352*Ti ±3.4cm (T1)	95.91 + 1.745*Ti ±3.9cm (T1b)	61.53 + 2.90*Ti ±3.66cm (T1)
Femur + Tibia	69.154 + 1.126*(Fe + Ti) ±3.1cm		53.20 + 1.39*(Fe + Ti) ±3.55cm

collated from Herrmann *et al.* (1990: 92ff.); in brackets, measurement after Martin and Saller (1957); S.D. for Pearson formulae after Rösing (1988)

If an individual provided multiple complete long bones, lower limb bones were preferred over upper limb bones for a body height estimate (Trotter and Gleser 1958).

Stature estimation from fragmented long bones (Steele 1970, with amendments by Jacobs 1992; Müller 1935 for the radius) was attempted but proved too unreliable with regard to the establishing of landmarks and was therefore abandoned, as the sample size resulting from stature estimation from complete long bones proved large enough for a representative sample.

4.2.1.6 Palaeopathological conditions

In order to form an informed picture of skeletal and dental health, stress indicators and living conditions for the people at Pleidelsheim and Neresheim, the following pathological conditions were assessed in this study, their identification following, in general, Ortner (2003), Aufderheide and Rodriguez-Martín (1998), Pinhasi and Mays (2008) and Roberts and Manchester (2005):

a) cribra orbitalia and porotic hyperostosis:

Both types of metabolic disease were recorded as present or absent. The scoring of cribra orbitalia required the presence of at least one intact orbit and followed the system devised by Stuart-Macadam (1991b), essentially classifying the observable lesion as porotic, cribrotic or trabecular. Scoring of porotic hyperostosis in the cranial vault followed Stuart-Macadam (1985).

b) non-specific infections:

Periosteal reactions were recorded by location in the skeleton and on the bone, size (i.e. focal or diffuse), type (i.e. woven, lamellar, or a combination of the two), and stage of healing (i.e. active, healing at the time of death, healed).

c) degenerative joint disease:

Following the criteria for assessing extra-vertebral degenerative joint disease established by Rogers & Waldron (1995) and Rogers (2000), the synovial joints of upper and lower limb were examined for absence or presence of marginal osteophyte formation, porotic changes to the joint surfaces, subchondral cysts, and eburnation. Eburnation presents clear evidence for osteoarthritis (Rogers *et al.* 1987 ; Rothschild 1997 ; Molnar *et al.* 2009). Any, or a combination of, other changes to the joint surface can be considered the result of degenerative changes or potentially as a precursor to osteoarthritis, while the occurrence of an actual inflammation, a precondition of osteoarthritis, cannot be established without doubt (Resnick and Niwayama 1988 ; Weiss and Jurmain 2007).

In the vertebral column, degenerative joint disease was recorded by region, due to a usually high fragmentation of remains. Presence and absence of the following conditions were examined:

- spondylosis,
- spondyloarthrosis,
- spondylolysis,
- Schmorl's nodes.

In case of the presence of indicators for spondylosis, severity was recorded following a scoring system as devised by Sager (1969) which differentiates between normal vertebral body morphology and the occurrence of marginal osteophytes, porotic changes to the bone underlying the vertebral endplate, and the advancement of these changes.

d) trauma:

Traumatic lesions were recorded on a presence / absence basis, by location in the skeleton and on the bone, type of traumatic injury (Judd 2002), time of occurrence (i.e. antemortem, perimortem, postmortem), and, if antemortem, the stage of healing. The recording of weapon trauma followed recommendations by Boylston (2004).

e) dental pathology:

Dental pathologies were recorded macroscopically on a presence / absence basis, by tooth or dental alveolus as well as by individual (i.e. the number of individuals showing evidence of dental pathology from the total of individuals with observable dentition) and comprised:

- antemortem tooth loss (if clear evidence of remodeling of the tooth socket),
- dental enamel hypoplasia (classification from mild to severe, after Ogden (2008a)),
- caries (by type, location and size, classification following Buikstra and Ubelaker (1994)),
- peri-apical disease (e.g. cysts, abscesses; following criteria established by Alt *et al.* (1998) and Ogden (2008b)),
- periodontal disease (after Ogden (2008a); calculus scored by severity after Brothwell (1981)).

Other pathological conditions observed in a skeleton (for instance, circulatory disruptions, infectious disease, neoplastic disease, or other types of metabolic disease) were recorded on a case-by-case basis.

4.2.1.7 Assessment of activity-related changes

Assessment of entheseal changes

The recording of entheseal changes (MSM) in this study followed the scoring systems established by Villotte (2006; 2009) and included the observation of the muscle attachments listed in Table 4.3, and scoring fibrocartilagenous and fibrous entheses separately. While, in general, the scale used in this study for scoring entheseal changes comprises

- score A = no entheseal changes present,
- score B = entheseal changes present,
- score C = major entheseal changes present,

the scoring devised for Groups 1 and 2 distinguishes fibrocartilagenous entheses, located at epiphyses and apophyses of long bones, and their characteristics from fibrous entheses, located on diaphyses and metaphyses, of the muscles listed in Group 4[87] (Table 4.3).

Table 4.3: Muscles examined in this study, grouped by type of enthesis and scoring characteristics

Group 1 (FC)[a)]	Group 2 (FC)[a)]	Group 4 (F)[b)]
M. subscapularis (humerus, supero-medial to smaller tubercle) (HSC)	M. triceps brachii (olecranon) (UTB)	M. pectoralis major (humerus) (HGP)
Mm supraspinatus & infraspinatus (humerus, superior & medial facets of greater tubercle) (HSI)	M. quadriceps femoris (patella) (PQF)	M. deltoideus (humerus, deltoid tuberosity) (HDE)
Mm medial epicondyle (HEM)	Achilles tendon (calcaneus) (Mm triceps surae) (CTS)	M. pronator teres (radius, medial part of lateral surface) (RRP)
Mm lateral epicondyle (HEL)		M. gluteus maximus (femur, gluteal tuberosity) (FGF)
M. biceps brachii (radius, medial part of tuberosity) (RBB)		Mm. vastus medialis, adductor magnus & longus (FLA)
Mm semimembranosus, semitendinosus & biceps femoris (ossa coxae, posterior side of ischial tubercle) (CSB)		M. soleus (tibia, inferior half of oblique line) (TSO)
M. gluteus minimus (femur, anterior side of greater trochanter) (FPF)		
M. gluteus medius (femur, lateral side of greater trochanter) (FMF)		
M. iliopsoas (femur, tip of lesser trochanter) (FIP)		

[a)] FC = fibrocartilagenous entheses, [b)] F = fibrous entheses

[87] The scoring system for Group 3, the observation of ligamentous insertions (fibrocartilagenous) on the vertebral column (Villotte 2006), was originally included in the skeletal analysis but eventually not employed in this study, as the assessment of entheseal changes in the axial skeleton had no interpretational value for this study.

Table 4.4 shows the scoring criteria as applied in this study. Muscular attachments falling into Group 1 (fibrocartilagenous, Table 4.3) require two separate scales of measuring remodelling, as both contour and centre (surface) of the enthesis can be affected, and albeit frequently being affected together, they necessitate a differential assessment of osseous changes (Villotte 2006). Both components of those entheses are scored separately and the scores then added in order to attribute the entheseal changes observed to a phase (equivalent to the scores A / B / C; Table 4.4). Fibrocartilagenous entheses of Group 2 (Table 4.3) are scored according to the presence or absence and appearance of osseous changes at the enthesis (Table 4.4), as remodelling at these attachments primarily affects the contour, and entheseal changes are easily measureable (Villotte 2006). Fibrous insertions (Group 4; Table 4.3) do not allow for a distinction between contour and centre of an enthesis but are characterized by poor demarcation and irregular remodelling (Benjamin *et al.* 2002 ; Villotte 2006) that are somewhat more difficult to assess and less measureable than the osseous changes occurring at fibrocartilagenous entheses (Table 4.4), hence care must be taken in the interpretation of changes to these entheses.

Entheses were considered not recordable if less than 50% of inner or outer part (Group 1 and 2) or less than half of the enthesis (Group 4) was observable (Mariotti *et al.* 2004 ; Havelková and Villotte 2007). Individuals displaying major pathological changes that could influence the development of entheseal changes were also not considered.

Table 4.4: Scoring of selected entheses (after Villotte 2006; 2009)

Group 1	
Score	***Description***
Contour	
0	absent: regular contour, without modification
1	minor: projecting or irregular contour (incl. small crest)
2	enthesophyte present, up to a clear irregular crest
Centre (surface)	
0	absent: regular surface, absence of foramen or cavity
1	minor: a) less than half of the surface shows one of the following: enthesophyte, irregularity, erosion, foramina or cavities; b) whole of surface shows slight irregularity, unevenness
2	major: more than half of the surface shows important modifications
Phase	
A	0
B	1 - 2
C	3 - 4

	Group 2	Group 4
Phase	***Description***	
A	absence of distinct enthesophyte or erosive layer; small signs may be present around contours	surface overall regular
B	a) presence of one or more small peripheral enthesophytes of less than or just about 2mm length	a) presence of irregularity clearly affecting the major part of insertion; absence of osseous production around insertion
	b) presence of erosive layer on level of centre; this surface is inferior or equal to half the surface of the whole insertion	b) presence of local lacuna in cortical bone, less than 20mm
C	a) presence of one or more small peripheral well developed enthesophytes of more than 2mm length	a) presence of irregularity clearly affecting the major part of insertion; presence of one big or multiple small reliefs to be distinguished from insertion
	b) presence of erosive layer on level of centre; this surface is superior to half the surface of the whole insertion	b) presence of local lacuna in cortical bone, equal to or more than 20mm

Intra- and inter-observer test

To measure observer agreement and the reliability of the applied scoring method, an intra-observer test and two inter-observer tests were conducted, including the author (I), one observer very experienced in scoring of entheseal changes (II), and one observer with only little experience in scoring of entheseal changes (III). For the assessment of intra- and inter-observer error, 25 skeletons with a good to very good degree of completeness from each Pleidelsheim and Neresheim were independently scored by the researchers. Table 4.5 shows the resulting concordance rates between observers, expressed with the Kappa coefficient to assess the quality of agreement between the observers (interpretation of Kappa value after Landis and Koch (1977)). The reproducibility of the scoring method was almost perfect when testing for intra-observer error, and substantial to almost perfect with regard to the inter-observer error. Further, the results proved to be very close to the levels of agreement in a comparative study for the reproducibility of this scoring system by Havelková and Villotte (2007). Thus, the applied method for scoring entheseal changes is very reliable and shows very high levels of reproducibility.

Table 4.5: Inter- and intraobserver error: Concordance rates

Scoring Group	Intraobserver		Interobserver I & II		Interobserver I & III	
	Kappa		Kappa		Kappa	
G1	0.92	almost perfect	0.79	substantial	0.65	substantial
G2	0.97	almost perfect	0.88	almost perfect	0.62	substantial
G4	0.94	almost perfect	0.75	substantial	0.60	substantial
Total	0.94	almost perfect	0.80	almost perfect	0.63	substantial

Other activity-related changes

For an assessment of activity-related markers with regard to the skeletal remains of individuals, a composition of observable activity-related traits was considered, pooled from the individual skeletal records and, following suggestions by Robb (1994), Kennedy (1989), and Capasso *et al.* (1999), including:

- enthesopathies,
- activity-related degenerative joint disease (vertebral and extra-vertebral),
- functional morphological alterations (e.g. joint facets),
- mechanical remodeling of long-bone diaphyses (visual assessment),
- traumatic lesions,
- dental modification.

In conjunction with other biological and archaeological markers, this allows for a characterisation of individual stress and activity levels per individual within a society.

4.2.2 Bioarchaeological analysis

4.2.2.1 Selection criteria for archaeological data

The cemeteries present a complex body of data that requires a contextual analysis of evidence provided by the funerary treatment and the physical body. To be able to conduct a bioarchaeological analysis, data on archaeological variables (i.e. on burial type, burial period, and grave good assemblages) were gathered from the archaeological publications on the cemeteries and the burial catalogues (Knaut 1993 for Neresheim; Koch 2001 for Pleidelsheim). The variety of individual grave goods (for instance, differentiated types of fibulae according to size and ornament) was categorised into broader groups (e.g. bow fibulae, disc fibulae, etc.) as suggested by Christlein (1991) and commonly found in Alamannic cemeteries, permitting the comparison of cemeteries as well as a purposeful analysis. Chronology was only considered for the entirety of grave good assemblages, not for individual items, and their potential age (i.e. dating to the period of burial or of much earlier date) and provenance were not of importance to this study and only considered in individual cases of interest for discussion. The presence of animal bones was noted but not included in the categorisation of grave good types.

By means of seriation of artefact types and (non-statistical) correspondence analysis[88] of burials, the archaeological data were examined for their combined occurrence and coherence as assemblages, as well as for the identification of grave goods and patterns of assemblages according to sex / gender and age. This was conducted on the basis of anthropological sex and age assessment only, as the use of archaeologically sex-determined grave good assemblages as applied by the archaeologists at both sites would suggest an unambiguousness of individual grave goods and their meaning for gender (Effros 2000) that cannot simply be assumed and would provide a false picture regarding artefactual significance for gender. This analysis permits a bioarchaeological examination devoid of any archaeological prejudice.

For the analysis of relationships between material and biological data, only those data from undisturbed burials were used, as the number of grave goods and artefact types in a burial assemblage was of relevance. With regard to endowment with weaponry, all burials of individuals with anthropologically assessed age and sex were considered if solely the presence or absence of weaponry was decisive.

4.2.2.2 Combination of archaeological and anthropological data

The bioarchaeological analysis of the populations of Pleidelsheim and Neresheim comprises a juxtaposition of funerary variables (burial types as well as material function- and fashion-related variables (Härke 1997d ; Jensen and Nielsen 1997))

[88] This rather heuristic approach to the examination of grave good assemblages, as opposed to a vast statistical correspondence analysis (Jensen and Nielsen 1997 ; Stoodley 1999) proved sufficient for the aims of this study, following the findings through similar approaches by Halsall (1996) and considering the results of this study.

with biological variables in order to explore biological and social status of individuals / groups of individuals within the population, and has been conducted as follows:

i. examination of archaeological data (artefactual evidence), and skeletal data (biological characteristics such as stature or activity-related traits and pathological variables, i.e. indicators for health and stress);
ii. analysis of interrelationships among both funerary and skeletal (biological and pathological) variables;
iii. analysis of relationships between funerary and skeletal (biological and pathological) variables, i.e. the skeletal remains in their funerary context:
    - combination of artefactual evidence with anthropological assessment of biological age and sex to establish gender associations of grave goods and burial assemblages and to approach a life course reconstruction and interpretation (as in Chapter 5)
    - examination of interdependencies between skeletal indicators and aspects of the burial rite to characterize the populations bioarchaeologically, explore the degree of agreement between biological and social 'status', and define potential subgroups within the cemetery populations (as in Chapters 6 and 7).

Each of the results chapters (cf. Chapters 5, 6 and 7) in this study follows this line of analysis according to the question approached in each section.

4.2.3 Statistical approaches

All data for this study were processed using Microsoft Excel©, and statistical analysis of the data, using the test appropriate to the type and combination of variables being analysed, was performed using SPSS (PASW)© for Windows statistical software, version 18.0, with accepted α - values set at 5%. Descriptive statistics (i.e. maximum, minimum, mean, standard deviation) were computed to assess the measurement results of biological variables, including the calculation of mean muscle scores. As not all skeletal elements or muscle attachment sites were present for all individuals, the calculation of means is based on the number of observable sites or elements. Individual conditions are presented as frequencies, computed as the number of affected (A) individuals or skeletal elements divided by the number of observed (O) individuals or skeletal elements. Thus, where applicable, true prevalence rates (TPR) have been calculated (Roberts and Cox 2003).

Furthermore, the statistical analysis comprised parametric and non-parametric tests, i.e. depending on the question, independent samples t-tests (two-tailed), χ^2 -tests or Fisher's Exact test (for sample sizes smaller than five, Cowgill 1977), one-way ANOVA, Mann Whitney U-test, Kruskal Wallis' H test, and Spearman's Rank Correlation Coefficient test. A detailed list of the statistical tests applied precedes each results chapter, according to the nature of problems investigated.

"Facts are the cobblestones from which we build roads of analysis, mosaic tiles that we fit together to compose pictures of past and present."
T. G. Ash, *Facts are Subversive*

5 Life and Death

This chapter presents the analysis of biological age and sex in Pleidelsheim and Neresheim in combination with data from the mortuary context, in order to arrive at a suggestion for establishing the life course and possible differences for males and females in both populations by the association of age and gender identities.

A general presentation of demography for each site is followed by a discussion of the archaeological artefacts and their relation to biological indicators of age and sex, with the grave good patterns then analysed for their relationship with age and gender identity in Pleidelsheim and Neresheim. We will eventually be able to discern differential mortuary behaviour for the two Alamannic populations, as well as divergent models for a life course approach.

The statistical methods employed in this chapter are descriptive statistics as well as independent t-tests and χ^2-tests for differences within and among the samples.

A note on condition and completeness of the skeletal samples

In the skeletal samples from Pleidelsheim and Neresheim, the condition of most skeletons ranged from good to extremely poor (Table 5.1; Table 5.3) with only a small percentage being preserved to a very good state due to taphonomic conditions as well as less than favourable storage, with considerable fragmentation encountered in many cases and the majority of skeletons being incomplete (Table 5.2; Table 5.4). In the case of adult skeletons, this severely limited the use of the pelvis and pubic symphysis for sex and age determination, as well as, to a great part, metrical analysis of long bones for stature estimation. Regarding subadult skeletons, the remains were either extremely poorly preserved or destroyed, often leaving only cranial indicators and the dentition as means for determining sex and age.

Table 5.1: Condition of the skeletons from Pleidelsheim

Condition	n˚ of skeletons	%
very good	19	9.5
good	30	15.0
fair	31	15.5
poor	51	25.5
very poor	34	17.0
extremely poor	35	17.5

Table 5.2: Completeness of the skeletons from Pleidelsheim

Completeness	n˚ of skeletons	%
> 75 %	40	20.0
75 - 50 %	38	19.0
50 - 25 %	38	19.0
< 25 %	84	42.0

Table 5.3: Condition of the skeletons from Neresheim

Condition	n˚ of skeletons	%
very good	10	7.5
good	15	11.3
fair	24	18.0
poor	29	21.8
very poor	12	9.0
extremely poor	43	32.3

Table 5.4: Completeness of the skeletons from Neresheim

Completeness	n˚ of skeletons	%
> 75 %	33	24.8
75 - 50 %	28	21.1
50 - 25 %	21	15.8
< 25 %	51	38.3

5.1 Demographic profiles: Age and sex distribution

Age and sex categorisation

Throughout the following analysis, a key for age categories as established in Table 5.5 will be used.

Table 5.5: Age groups and keys as used throughout this work

Age category	*Age range*	*Key*	*Combined Age Category*	*Key*
Children		**C**		
foetus	under 40 weeks	-	child	**C**
neonate	birth - 1 month	-		
infant	1 - 12 months	-		
early childhood	1 - 6 years	**ECH**		
late childhood	7 - 12 years	**LCH**		
Adults		**A**		
adolescent	13 - 17 years	**AD**	young adult	**YA**
young adult	18 - 25 years	**YA**		
young middle adult	26 - 35 years	**YMA**	middle adult	**MA**
old middle adult	36 - 45 years	**OMA**		
mature adult	46 - 59 years	**MTA**	old adult	**OA**
old adult	60+ years	**OA**		

There was no record of children below one year of age, i.e. of fetal or neonate age-at-death, in the skeletal samples of Pleidelsheim and Neresheim[89]. This may be due either to excavation bias, taphonomy or to the place of burial within the incompletely excavated cemeteries of these individuals (Lohrke 2004a: 38f.). Regarding the investigations into funerary context for both cemeteries, it has to be noted that during the skeletal analysis, the skeletal remains of several infants and children emerged among the remains of adult burials which could not be identified in the archaeological account of the cemetery catalogue (Knaut 1993 ; Koch 2001). This occurrence has been already observed before (e.g. Brather 2004b) and

[89] with the exception of the skeletal remains of an infant aged between 0 - 6 months, found together with the remains of a female skeleton in burial n˚ 56 (cf. App. 4, Table 2).

contributes to the difficulty of describing subadult mortality and analysing the position of children in Alamannic cemeteries.

Very few cases of children of infant age were recorded, and their numbers are extremely underrepresented; in the case of differential burial circumstances, this will be highlighted, otherwise these individuals have been included in the early childhood age bracket for this analysis.

Adolescents were treated as a separate age group for the analysis of the mortuary context and skeletal analysis. However, if occurring among the adult sample during the following skeletal analysis, these are individuals that could be confidently aged to 16 - 18 years of age.

Sex determination is solely based on anthropological assessment. The tables containing details for the burials in Pleidelsheim and Neresheim (App. 5, Tables 7 - 12 (Pleidelsheim), 13 - 18 (Neresheim)) additionally list the assigned 'archaeological sex' as preferred by the archaeologists, highlighting the discrepancies between artefactual and biological sex determination.

Initially, the individuals were assigned to one of the following sex categories: male (M), probable male M?), female (F), probable female (F?), indeterminate (I). For the purpose of analysis, the probable cases were assigned to the male (M) or, respectively, female (F) category. In the keys used for the tables throughout this work, 'M' for male and 'F' for female will occur in combination with the code for an age category (e.g. 'YAM' for 'young adult male', 'OAF' for 'old adult female').

This study included 430 inhumations overall from the cemeteries of Pleidelsheim and Neresheim. For both Pleidelsheim and Neresheim, the numbers of individuals listed among 'all individuals' (App. 5, Tables 1 and 2) will be used throughout this investigation for aspects concerning the skeletal analysis as well as certain aspects of the investigation of material culture in the burials; however, only intact burials (App. 5, Tables 3 and 4) were considered for the analysis of any detail regarding the meaning of grave goods, as only for those burials, a direct association and evaluation of biological and archaeological data could be considered and evaluated.

5.1.1 Pleidelsheim

The assemblage from the cemetery of Pleidelsheim comprised 266 individuals, 216 adults and 50 subadults. Sex and age distribution for the skeletal sample from Pleidelsheim is depicted in Fig. 5.1. Those individuals falling into the general age category 'Adult' (A) or 'Child' (C), i.e. skeletons of unknown age but with clear characteristics of either adults or children, are not included in the graphical representation of the population profile. A detailed account of age and sex distribution for the examined samples can be found in App. 5, Tables 1 and 3.

For this skeletal sample, age and sex could be identified for 105 males and 109 females, among them the skeletons of 14 subadult boys and 13 girls. As Table 2 (App. 5) shows, the sex remained indeterminate in 52 cases (29 adults, 23 children) and was not subsequently assigned by the character of the grave good assemblage, as this was considered unsuitable for the present study.

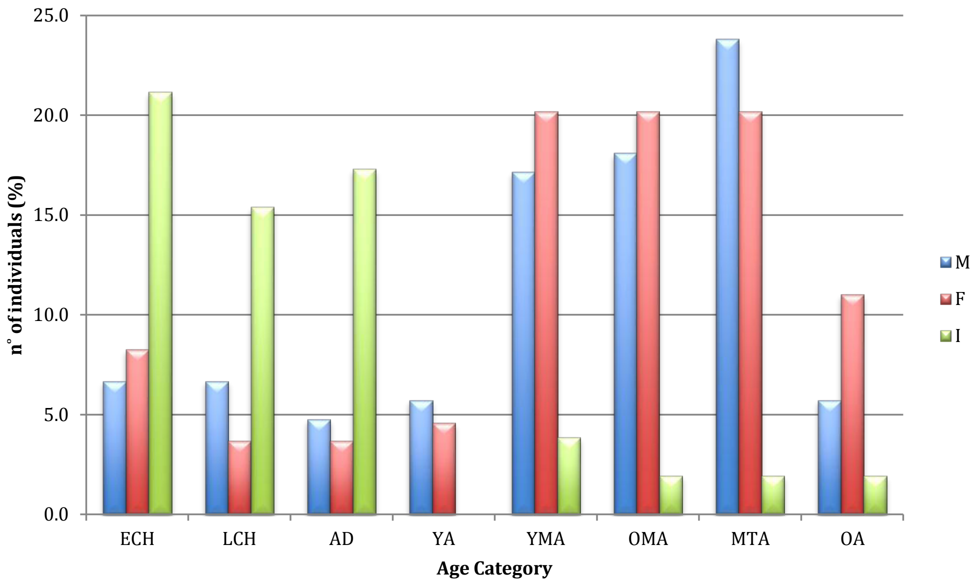


Fig. 5.1: Pleidelsheim - Distribution of sex and age-at-death for the entire population

Children of determinable age and sex constitute 36 % of the sample, adults 76 % (Fig. 5.2; Fig. 5.3). For both children and adults, no predominance of either sex could be detected.

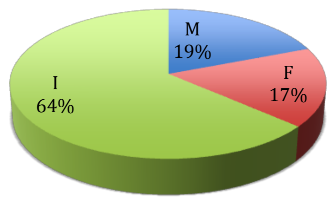


Fig. 5.2: Pleidelsheim - Sex of the deceased - Child

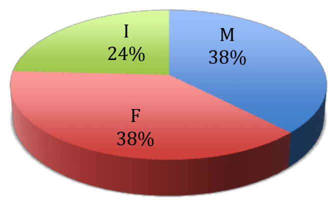


Fig. 5.3: Pleidelsheim - Sex of the deceased - Adult

The calculation of the masculinity index[90], i.e. the proportion of males to females at Pleidelsheim, resulted in an MI (total) = 96.3, with an MI (adults, 18+ years) = 94.8, and an MI (subadults) = 107.7, thus a balanced sex distribution close to normal biological proportions (Herrmann *et al.* 1990: 310; Siegmund 2009).

Regarding age-at-death, adult deaths were highest between the ages of ca. 35 to 59 years (young middle adult to mature adult), with almost equal proportions for males and females throughout (Fig. 5.1; Fig. 5.4; Fig. 5.5). Some 5.7 % of the male and 11 % of the female population in Pleidelsheim survived into old age, set here as being over 60 years of age.

In the subadult sample, deaths among individuals in early and late childhood, as well as in adolescence, were confined to very low numbers, with slightly more girls passing away in early childhood (8.3 %) and less in late childhood and adolescence (3.7%; Fig. 5.1; Fig. 5.5), while numbers for death occurring among boys remain the same for these categories (Fig. 5.4).

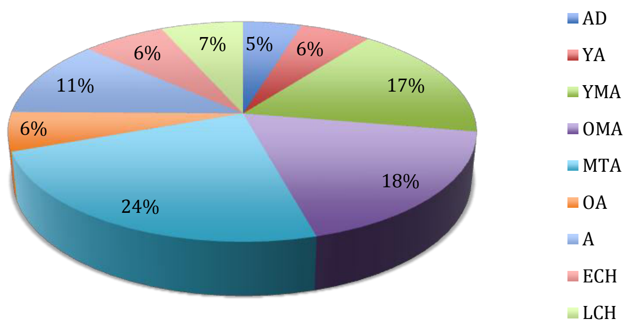


Fig. 5.4: Pleidelsheim - Male Age Distribution

[90] MI = number of males / number of females *100; a balanced sex distribution is considered when MI = 100, i.e. a proportion of males of 50%, an MI of < 100 points to an excess of males, an MI of > 100 to an excess of females (Herrmann *et al.* 1990: 310).

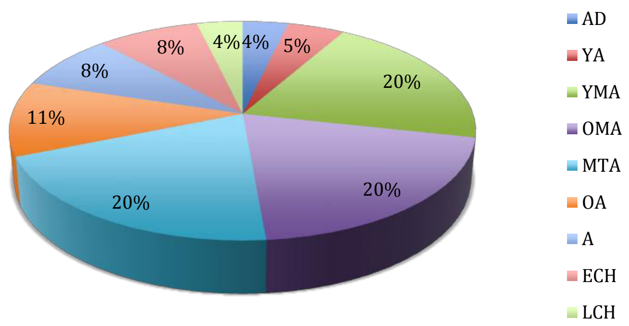


Fig. 5.5: Pleidelsheim - Female Age Distribution

As the sex and age-at-death profile for intact burials only (Fig. 5.6) shows more clearly, the mortality distribution follows a pattern commonly observed in archaeological populations (Chamberlain 2006), with no significant differences between males and females in this case.

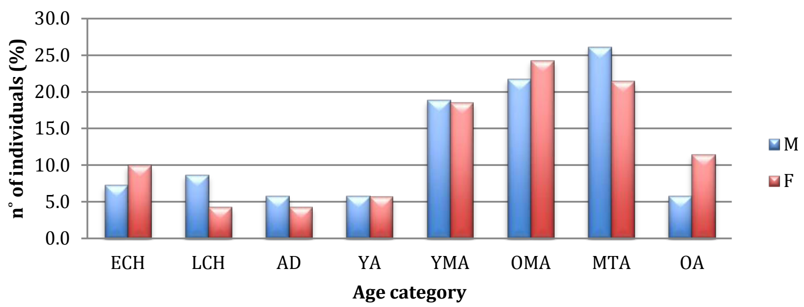


Fig. 5.6: Pleidelsheim - Distribution of sex and age-at-death in intact burials (anthropologically age- and sex-determined individuals)

5.1.2 Neresheim

With a total of 164 burials containing skeletal remains, the skeletal sample from Neresheim comprised fewer individuals than the one from Pleidelsheim, with 138 adults and 26 subadults (App. 5, Tables 2 and 4). Biological age and sex could be assessed for 56 males and 96 females, among them the skeletal remains of ten subadult boys and girls for each site.

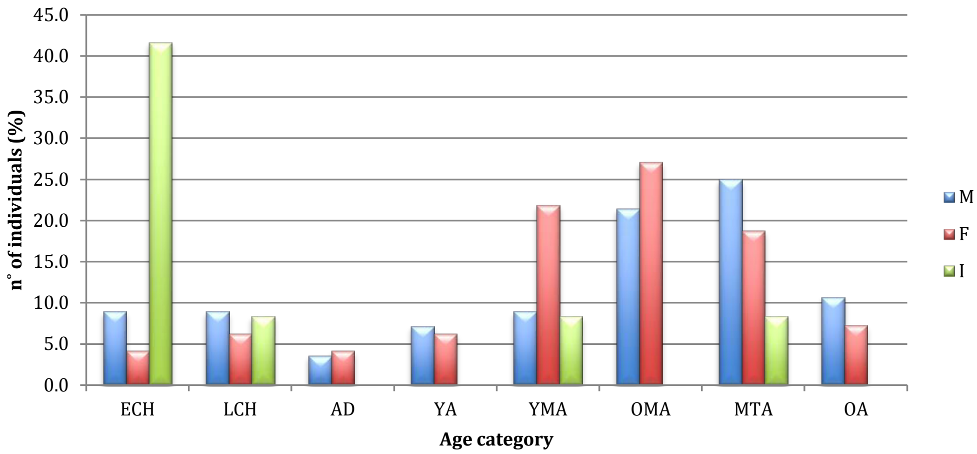


Fig. 5.7: Neresheim - Distribution of sex and age-at-death for the entire population

As Fig. 5.7 shows, we encounter a similar sex distribution and mortality profile to Pleidelsheim: with age and sex - determined children accounting for 36 % of the sample and male and female adults for 77%, also in this population there is no overall predominance of either sex to be detected in the mortality profile (Fig. 5.8; Fig. 5.9). However, the masculinity index (MI) for Neresheim resulted in an MI (total) = 58.3, with an MI (adults, 18+ years) = 53.5, and an MI (subadults) = 100, implying a deviation from a balanced sex distribution for adults (Siegmund 2009), with a greater proportion of adult females at Neresheim.

We observe relatively low numbers of deaths in childhood and adolescence, with and increase in young middle adulthood and a decrease again with old age (Fig. 5.7; Fig. 5.12). Contrary to the profile for Pleidelsheim, slightly more males (10.7 %) than females (7.3 %) survive into old age (OA).

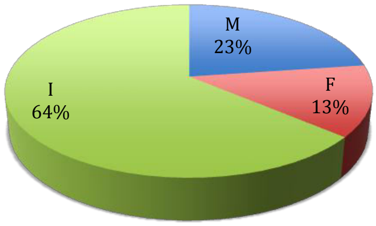


Fig. 5.8: Neresheim - Sex of the deceased - Child

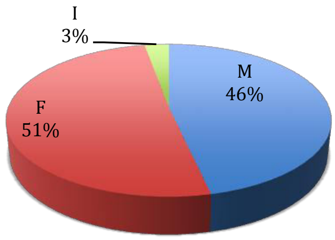


Fig. 5.9: Neresheim - Sex of the deceased - Adult

However, one important difference between the two cemeteries is revealed when examining the age-at-death distribution in more detail. While the distribution in both male and female population shows, in most parts, strong similarities in age-at-death distribution among the sexes to those in Pleidelsheim (Fig. 5.10; Fig. 5.11), there is a significant difference in the prevalence of deaths in the YMA category, with many more females (21.9 %) than males (8.9 %) in Neresheim passing away between the age of ca. 26 - 35 years ($p = .041^*$, $N = 152$, $\chi = 4.181$), an occurrence very likely related to childbearing age and death in childbirth.

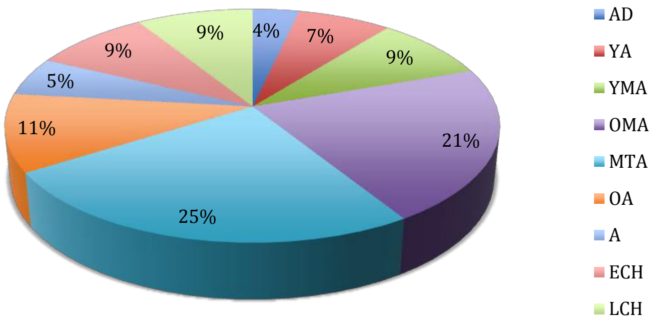


Fig. 5.10: Neresheim - Male Age Distribution

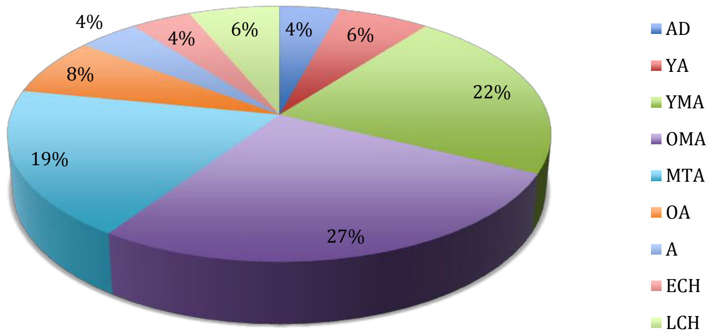


Fig. 5.11: Neresheim - Female Age Distribution

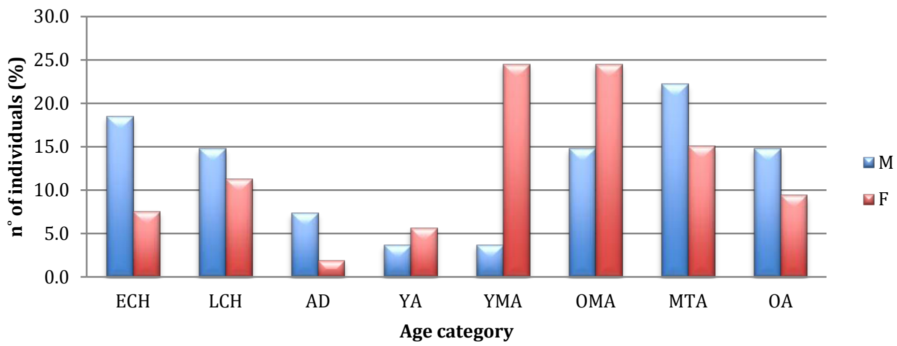


Fig. 5.12: Neresheim - Distribution of sex and age-at-death in intact burials (anthropologically age- and sex-determined individuals)

This is even more highlighted when looking at intact burials from Neresheim only (Fig. 5.12), with a significant difference for the occurrence of death in young middle adulthood females as opposed to males at $p = .02^*$ ($N = 80$, $\chi = 5.373$).

The only other difference between Pleidelsheim and Neresheim with regard to sex and age-at-death distribution, possibly interesting for further considerations albeit not statistically significant, is the comparison of deaths among the subadult sample (Fig. 5.13). Almost to the contrary at Pleidelsheim, in Neresheim, the rate of death is higher among boys, particularly in early childhood (8.9%, as opposed to 4.2% in girls, and much more strongly pronounced in intact burials only, with 18.5% (M) versus 7.5% (F), App. 5, Table 4).

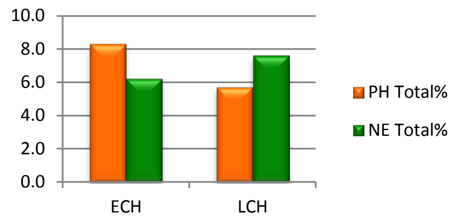


Fig. 5.13: Comparison of Child Age Distribution (total populations)

Overall, differential mortality in adulthood is much less pronounced in Pleidelsheim than in Neresheim.

5.1.3 Age and sex distribution by burial type

Where the type of burial was identifiable (cf. Chapter 2.2.1), males and females in their different age categories were analysed for differences among the three groups of burial type (Fig. 5.14):

Burial types PH:
A = coffin burials (includes graves with remaining traces of wood), with grave goods placed at side of the interred individual
B = "simple" burials (burial pits)
C = burial chamber (more than 100cm wide)
[D = double burial]

Burial types NE:
A = coffin burials (includes graves with remaining traces of wood), tree trunk coffins
B = [simple] burial pit
C = burial chamber (more than 100cm wide)

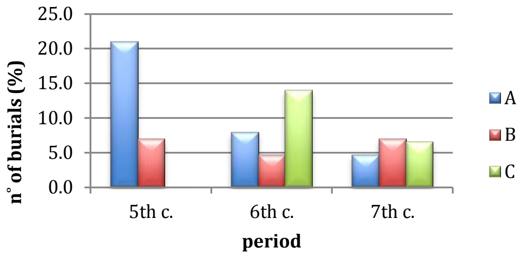
Fig. 5.14: Synthesis of burial type and grave furniture for Pleidelsheim and Neresheim

In Pleidelsheim, there is a comparatively high prevalence of coffin burials (type A) during the 5th c. AD, which subsides with the 6th and 7th centuries (Table 5.6; Fig. 5.15). While the custom of interment in very simple graves (type B) remains almost unchanged across the periods under study, chamber graves only appear with the advent of the 6th c. AD.

Table 5.6: Pleidelsheim - Distribution of burial types across the centuries (all burials except indet.)

Burial Type	*Period* 5th c.	6th c.	7th c.	n. d.	Total
A	45	17	10	1	73
B	15	10	15	0	40
C	0	30	14	1	45
n. d.	8	13	9	26	56
Total	68	70	48	28	214

Fig. 5.15 Pleidelsheim - Distribution of burial types across the centuries

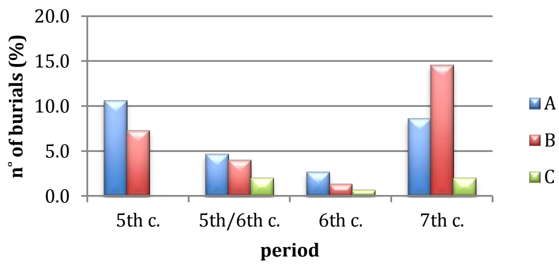


In Neresheim, we find a similar distribution of the three burial types over the centuries, with the onset of chamber graves in the transition period from the 5th to the 6th c. AD (Table 5.7; Fig. 5.16). However, there are considerably fewer chamber burials during the 6th and 7th c., compared to Pleidelsheim, and a remarkable increase of simple graves among the burials with the 7th c. AD.

Table 5.7: Neresheim - Distribution of burial types across the centuries (all burials except indet.)

Burial Type	5th c.	*Period* 5th / 6th c.	6th c.	7th c.	n. d.	Total
A	16	7	4	13	26	66
B	11	6	2	22	35	76
C	0	3	1	3	2	9
Total	27	16	7	38	63	151

Fig. 5.16: Neresheim - Distribution of burial types across the centuries



A detailed description of the findings regarding the distribution of biological sex and age for both populations can be found in App. 5, Tables 5 and 6.

In the Pleidelsheim sample, the majority (47.6 %) of individuals were interred in coffin burials (type A), 26.6 % in simple burials (type B), and another 25.9 % of the population in chamber graves (type C), with only small differences between males and females for the latter two burial types. While for females, no distinct preponderance in burial type can be noted (App. 5, Tables 5; Fig. 5.18), males in Pleidelsheim were predominantly buried in coffins ($p = .000^{**}$, $N = 210$, $\chi = 33.600$; Fig. 5.17), and significantly more frequently so than females ($p = .004^{**}$, $N = 143$, $\chi = 8.519$). This applies especially for MTA (ca. 46 - 59 years), with significantly more males than females buried in coffins ($p = .021^{*}$, $N = 143$, $\chi = 5.364$) - but, at the same time (and age), more females were buried in chamber graves than in coffins or simple burials, something that otherwise only occurs in young middle adulthood in this sample (App. 5, Tables 5).

This most elaborate type of burial (type C) is, in general, occupied by deceased of both sexes, from YA to MTA individuals as well as older aged women (OA, 2.7 %; Fig. 5.18), a number that contributes to overall more females than males being buried in chamber graves. While we find boys in early, but not in late childhood, in chamber graves here, it is the contrary for girls, although very small sample sizes do not allow for any further assessment.

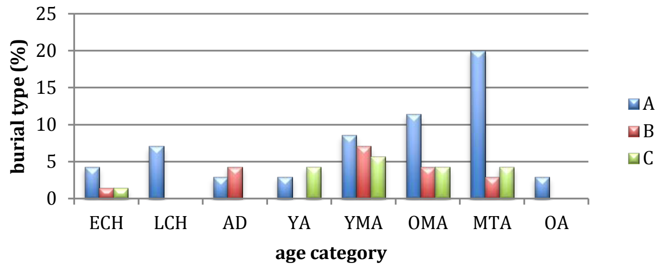


Fig. 5.17: Age distribution of males in Pleidelsheim in different burial types

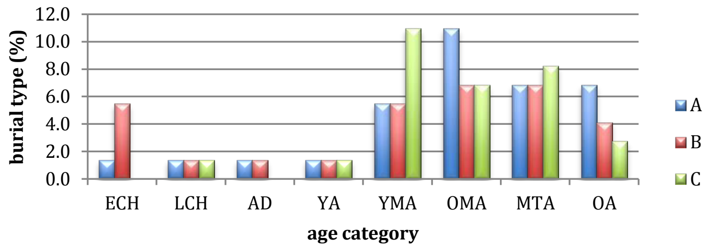


Fig. 5.18: Age distribution of females in Pleidelsheim in different burial types

In Neresheim, we encounter a very different degree of distinction regarding burial type, gender and age (Fig. 5.19; Fig. 5.20; App. 5, Table 6).

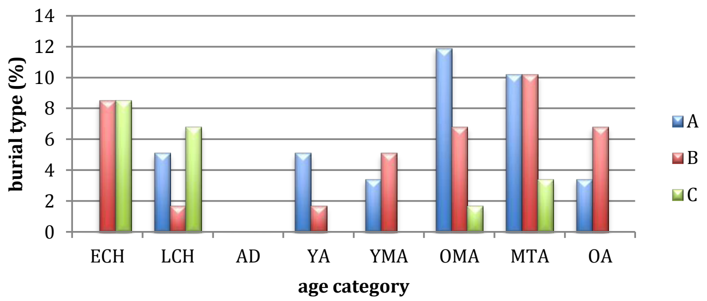


Fig. 5.19: Age distribution of males in Neresheim in different burial types

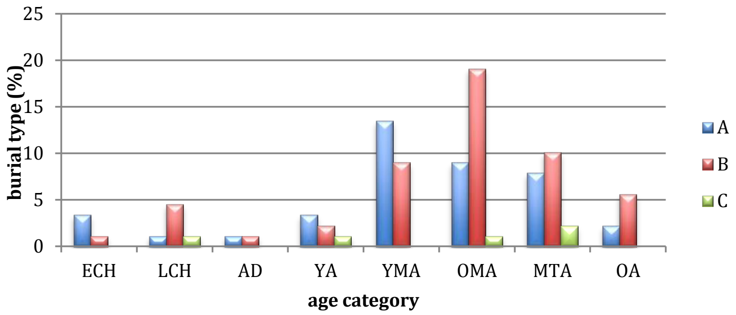


Fig. 5.20: Age distribution of females in Neresheim in different burial types

Overall, we find 48 % of the population interred in simple burials, 40.5 % in coffins and only 11.5 % in chamber burials. This constitutes a highly significant difference in burial mode between Pleidelsheim and Neresheim regarding simple burials (p = .000**, N = 291, χ = 14.217), with significantly more individuals in Neresheim buried in this most simple style than found in Pleidelsheim, as well as regarding the deposition in chamber graves (p = .002**, N = 291, χ = 9.962), with more individuals in Pleidelsheim being buried in grave chambers, a prevalence that may be related to differing burial styles depending on period and cultural influence, however.

While in Neresheim the numbers of deceased males and females in coffin and simple burials do not differ significantly, they do for the interment in grave chambers (type C): 20.3% of males were buried in this most elaborate grave type, but only 5.6 % of females (p = .006**, N = 148, χ = 7.562). When considering age-related differences, the use of grave chambers is limited to OMA and MTA for both sexes and, interestingly, additionally to YA females. Considering males, we also find a considerable proportion of type C burials for early and late childhood, whereas girls were only buried in this grave type when passing away in late childhood. Interestingly, however, exactly as many boys' burials in early childhood could be found for the most simple graves (type B), while girls throughout the entire childhood period are being interred in simple as well as coffin burials, with a slight albeit non-significant preponderance of coffin over simple burials in early childhood. Of further importance is the finding of a very significant difference in Neresheim between males and females at an age-at-death of ca. 36 - 45 years (OMA): around three times as many females than males were buried in most simple manner (type B; OMA F 19.1 % : M 6.8 %, $p = .035^*$, $N = 148$, $\chi = 4.424$; cf. App. 5, Table 6). This difference, not occurring in any other age category, is levelled again in burials of old adults.

5.2 Funerary evidence and biological data

As described in Chapter 2.3.1, Christlein (1991) proposed sets of 'male', 'female' and 'neutral' grave good assemblages, with associated qualities of material value for every artefact type (cf. Chapter 2.3.1, Table 2.4 and Table 2.5). This somewhat antiquated classification into 'masculine', 'feminine' and 'neutral' groups of artefacts has been long since debated and slightly varied (e.g. Brather 2008), but was never really contested, tested, revised or abandoned.

Based on Christlein's suggestions as well as on those by subsequent Alamannic cemetery analyses, all intact burials in Pleidelsheim and Neresheim were evaluated with regard to their grave goods, in order to establish a) which artefacts co-occurred in the burials, b) which artefacts indicate a more or less strong gender association, and c) to create grave seriation tables which would permit investigation of the association of biological sex and age with the distribution of grave goods in the mortuary context. This procedure leads to an informed understanding of the burial rite and grave good deposition with regards to age and sex of the deceased.

The following grave goods were included in the listings for the burials of Pleidelsheim and Neresheim (the categorization indicating prevailing gender attributions):

"Masculine"

weaponry
sword (= *spatha*)
seax
bow
arrow(s)
shield
lance
spear (= *ango*)
helmet / armour
axe

Horse equipment
snaffle & harness
spur

Other
wooden bucket
tools

N.B.:
shield boss = shield; arrowheads = arrow
Ag = silver, Au = gold, Br = bronze, Fe = iron, Gl = glass, Ant = antler, Wd = wood, Bn = bone
Grave goods after Christlein (1973, 1991),with additions from burial catalogues (Koch 2001, Knaut 1993)

"Neutral"

glassware
bronze ware
bucket with bronze fittings
golden ring
ring (Br/Ag)
coin(s)
(belt) buckle (Ag/Br)
belt set / girdle hanger
    belt buckle (Fe)
comb
pottery
knife (Fe)
goldleaf cross
amulet
scissors
tweezers
flint

"Feminine"

beads
    gold beads
    glass beads
    bronze beads
Jewellery
bracelet
necklace
earrings (Au/Ag/Br)

Adornments
fibula (Au/Ag)
bow fibula
disc fibula
small fibula
calf decoration (Ag/Fe/Br/metal)
hairpin
(sewing) needle

Other
wooden casket (with bone or metal fittings)
spindle whorl
weaving sword
key(s)
bucket sleeve & set

'Grave Good' and 'Artefact types': A worthwhile distinction?

In the following analysis, the term 'grave goods' (subsequently abbreviated to 'GG') refers to all objects that were placed into the grave with the dead and therefore informs about the number of items with which the deceased were provided (e.g. "three arrows").

Since the aim is to acquire information about the *variety* as well as quantity that a grave assemblage can constitute, sets of certain grave goods of the same type are grouped as 'artefact types' (e.g. "three arrows" = one artefact type "arrow"; subsequently abbreviated with 'AT'), offering us valuable insights into patterns of artefact meaning which would be lost when looking merely at numbers of grave goods. It can be demonstrated *a priori* by a simple comparison of the distribution of the two distinctions in artefact count.

When plotting 'grave goods' against 'artefact types' in Pleidelsheim, the following picture emerges:

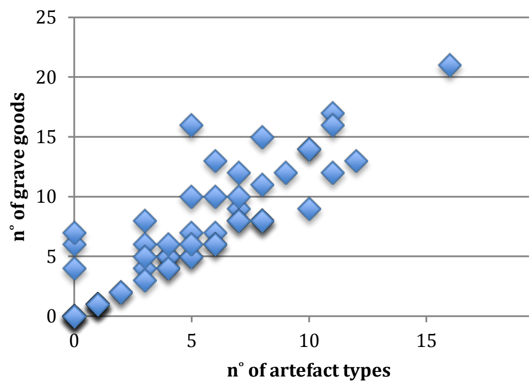


Fig. 5.21: Pleidelsheim - Distribution of grave goods and artefact types in male burials

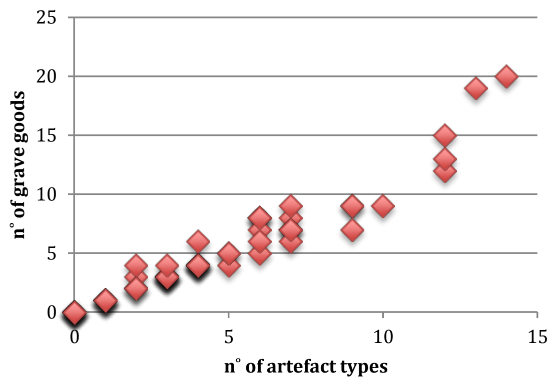


Fig. 5.22: Pleidelsheim - Distribution of grave goods and artefact types in female burials

The number of GG conform relatively well to the number of AT in both cases, and, of course, an increasing number of GG entails an increasing number of AT (Fig. 5.21, Fig. 5.22). Except for a few outliers, which will be explored at a later stage, clusters of GG and AT are dispersed in the male sample, the reason for which will become apparent when looking at age-related artefact distribution later in this chapter.

In Neresheim, a slightly varying, though essentially similar picture materializes:

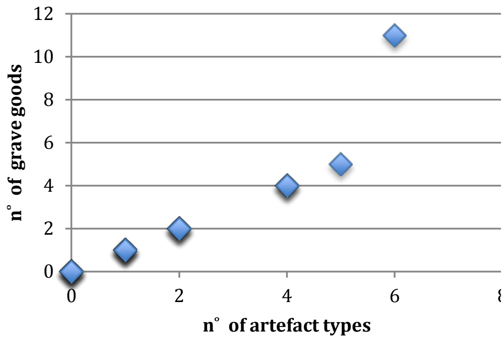


Fig. 5.23: Neresheim - Distribution of grave goods and artefact types in male burials

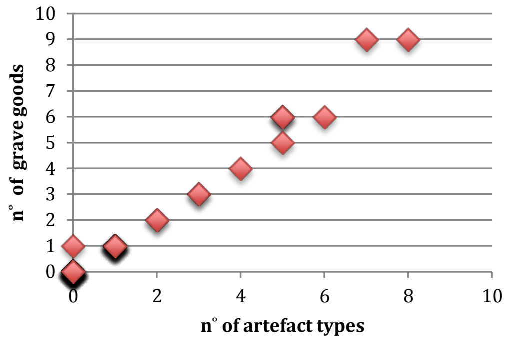


Fig. 5.24: Neresheim - Distribution of grave goods and artefact types in female burials

It provides the preliminary impression that in Neresheim, we encounter the deposition of far less GG and AT than in Pleidelsheim. Further, it can be noted that females seem to have more AT than males in Neresheim (Fig. 5.23, Fig. 5.24).

These elementary comparisons already indicate the significance of biological sex for the exploration of patterns of material culture and their meaning regarding life course and identity reconstruction in these two populations.

5.2.1 Biological Sex and Gendered Artefacts

Establishing 'gendered' artefact types

A survey of which AT are most often associated with each other reveals a picture for the cemeteries under study that renders a classification of objects into commonly assumed gendered groups (for instance, weaponry = always male burial, jewellery = always female burial) questionable.

In Fig. 5.25 and Fig. 5.26, GG were divided into a series of AT and then plotted in identical order following the above listing of GG (see p. 156) on the *x*- and *y*-axes, with weaponry placed nearest to the origin on the left-hand side, jewellery and 'other' archaeologically female-gendered objects to the opposite side, and other items (among them 'neutral' objects) in between. Following suggestions made by Halsall (1996), an AT *x* had to be associated with an AT *y* in one or more intact graves in order to be recorded. A burial containing two or more AT, based on the concept that if an object was placed intentionally into two or more burials, would appear to bear a certain degree of (symbolic?) meaning (Halsall 1996: 81).

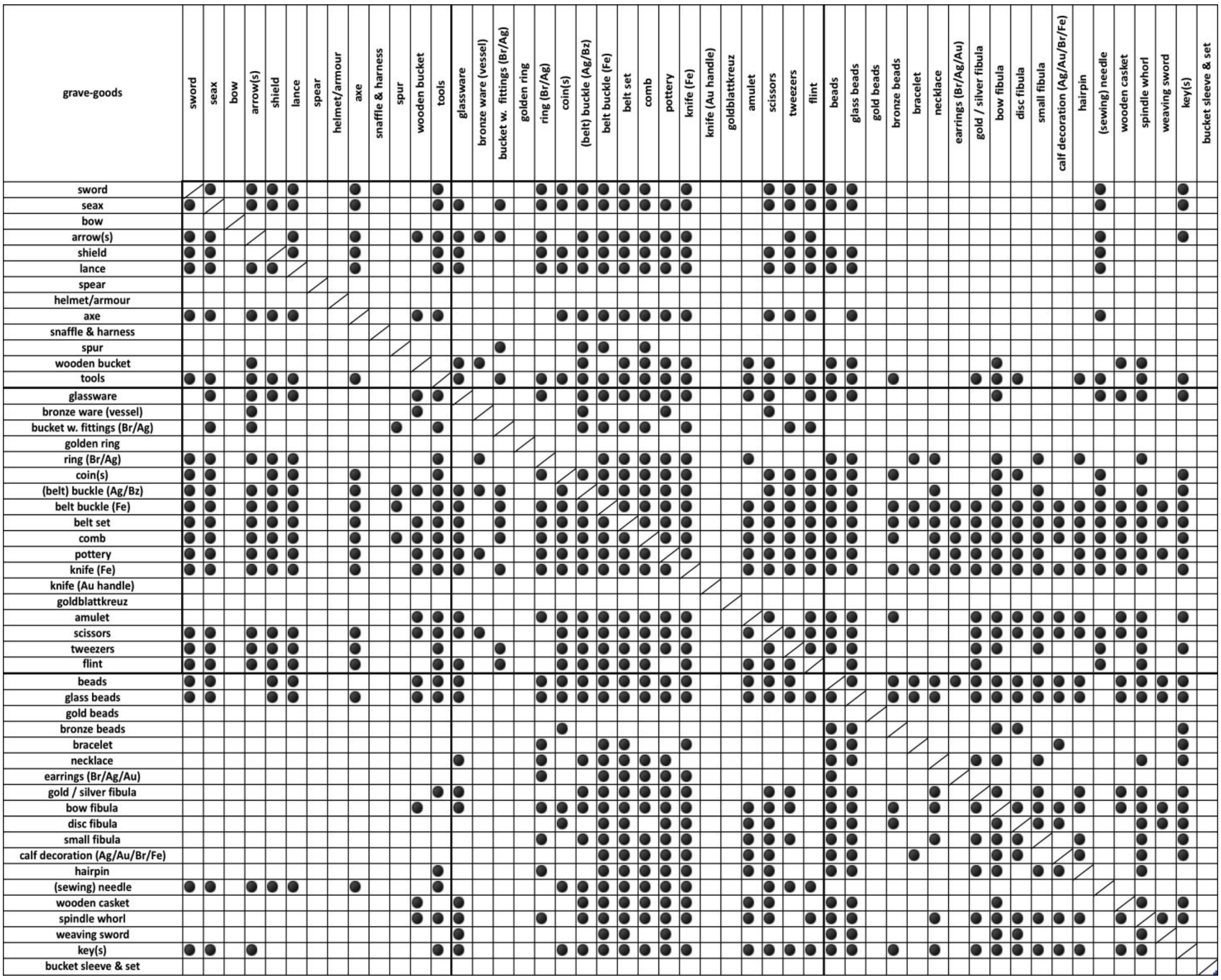


Fig. 5.25: Pleidelsheim - Co-occurrence of artefact types (a larger version of this figure can be found in App. 5, Fig. 25 - 28)

grave-goods	sword	seax	bow	arrow(s)	shield	lance	spear	helmet/armour	axe	snaffle & harness	spur	wooden bucket	tools	glassware	bronze ware (vessel)	bucket w. fittings (Br/Ag)	golden ring	ring (Br/Ag)	coin(s)	(belt) buckle (Ag/Bz)	belt buckle (Fe)	belt set	comb	pottery	knife (Fe)	knife (Au handle)	goldblattkreuz	amulet	scissors	tweezers	flint	beads	glass beads	gold beads	bracelet	necklace	earrings (Br/Ag/Au)	gold / silver fibula	bow fibula	disc fibula	small fibula	calf decoration	hairpin	(sewing) needle	wooden casket	spindle whorl	weaving sword	key(s)	bucket sleeve & set
sword	/	●			●	●								●								●			●						●																		
seax	●	/			●	●																●					●																						
bow			/																																														
arrow(s)				/									●									●			●					●	●													●					
shield	●	●				●																●																											
lance	●	●			●	/																●																											
spear							/																																										
helmet/armour								/																																									
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snaffle & harness										/																																							
spur											/																																						
wooden bucket												/																																					
tools													/												●					●	●																		
glassware	●													/							●	●			●						●	●	●					●			●								
bronze ware (vessel)															/																																		
bucket w. fittings (Br/Ag)																/																																	
golden ring																	/																																
ring (Br/Ag)																		/	●		●				●								●																
coin(s)																			/			●			●								●																
(belt) buckle (Ag/Bz)																				/		●			●																								
belt buckle (Fe)		●		●									●	●					●		/	●		●	●					●	●	●	●					●								●			●
belt set	●	●		●	●	●							●	●							●	/			●		●			●	●	●	●				●		●		●			●		●			●
comb																							/																										
pottery				●																	●			/						●									●		●								
knife (Fe)	●			●									●	●					●	●	●	●			/					●	●	●	●				●	●	●		●			●		●			●
knife (Au handle)																										/																							
goldblattkreuz		●																				●					/																						
amulet																												/				●						●	●										●
scissors																													/																				
tweezers													●								●			●	●					/	●																		
flint	●													●								●			●					●	/																		
beads														●							●	●			●			●				/	●					●			●								●
glass beads														●					●		●	●										●	/				●												●
gold beads																																		/															
bracelet																									●							●			/			●	●										
necklace																																				/													
earrings (Br/Ag/Au)																						●											●				/		●		●								
gold / silver fibula														●											●			●				●			●			/	●										●
bow fibula																			●		●	●			●			●				●	●		●		●	●	/										●
disc fibula																																								/	●								
small fibula														●								●										●					●		●		/								
calf decoration (Ag/Au/Br/Fe)																																										/							
(sewing) needle				●																																							/						
hairpin																					●	●										●	●											/		●			●
wooden casket																																													/				
spindle whorl																					●	●			●							●	●													/			●
weaving sword																																															/		
key(s)																																																/	
bucket sleeve & set																					●	●			●			●				●	●					●	●							●			/

Fig. 5.26: Neresheim - Co-occurrence of artefact types (a larger version of this figure can be found in App. 5, Fig. 25 - 28)

This exploration of co-occurrence of AT for both Pleidelsheim and Neresheim proves only marginally illuminating. In both cases, we find a much less clear demarcation of exclusively male, neutral and female AT than suggested by the archaeologists, as many AT listed as either 'masculine' or 'feminine' in Alamannic burials are found in combination with objects from the "opposite" group, and the majority of artefacts is found in the middle, i.e. as belonging into the 'neutral' category.

A closer examination of the artefact distribution at the two cemetery sites used only anthropologically sex-determined individuals[91], intact burials and their material assemblages. In the resulting grave seriation tables (Fig. 5.27, Fig. 5.28), again following suggestions made by Halsall (1996), the earlier listed sequence of AT (from 'masculine' as opposed to 'neutral' and to 'feminine kit) can be found in the *x*-axis (header row), the list of intact graves on the *y*-axis (left-hand column). The data in the two right-hand columns in the tables are ordered by a) biological sex (male - female; division marked by dashed line), as well as b) age category (early childhood to old adulthood). A detailed account of the artefacts found in each grave can be found in the Appendix (5, Tables 7 - 12 (Pleidelsheim), 13 - 18 (Neresheim)).

To obtain a seriation, AT found in grave number *y* were plotted following the arrangement given in the *x*-axis. Ideally, we should be able to see a distribution of object entries within these seriation tables that would take us from overall strongly male grave assemblages (left-hand side and first half of the table), to those distinctly female (right-hand side and lower half of the table)[92].

[91] Originally, the tables also included indeterminate individuals, which would possibly facilitate an attribution towards biological sex. However, this is not the purpose of this work, and there is no suggestion favouring an attempt to determine sex from grave inclusions in this work.

[92] In the grave seriation tables, items belonging to the "masculine" assemblage are circled in blue, to the "neutral" assemblage in green, to the "female" assemblage in red.

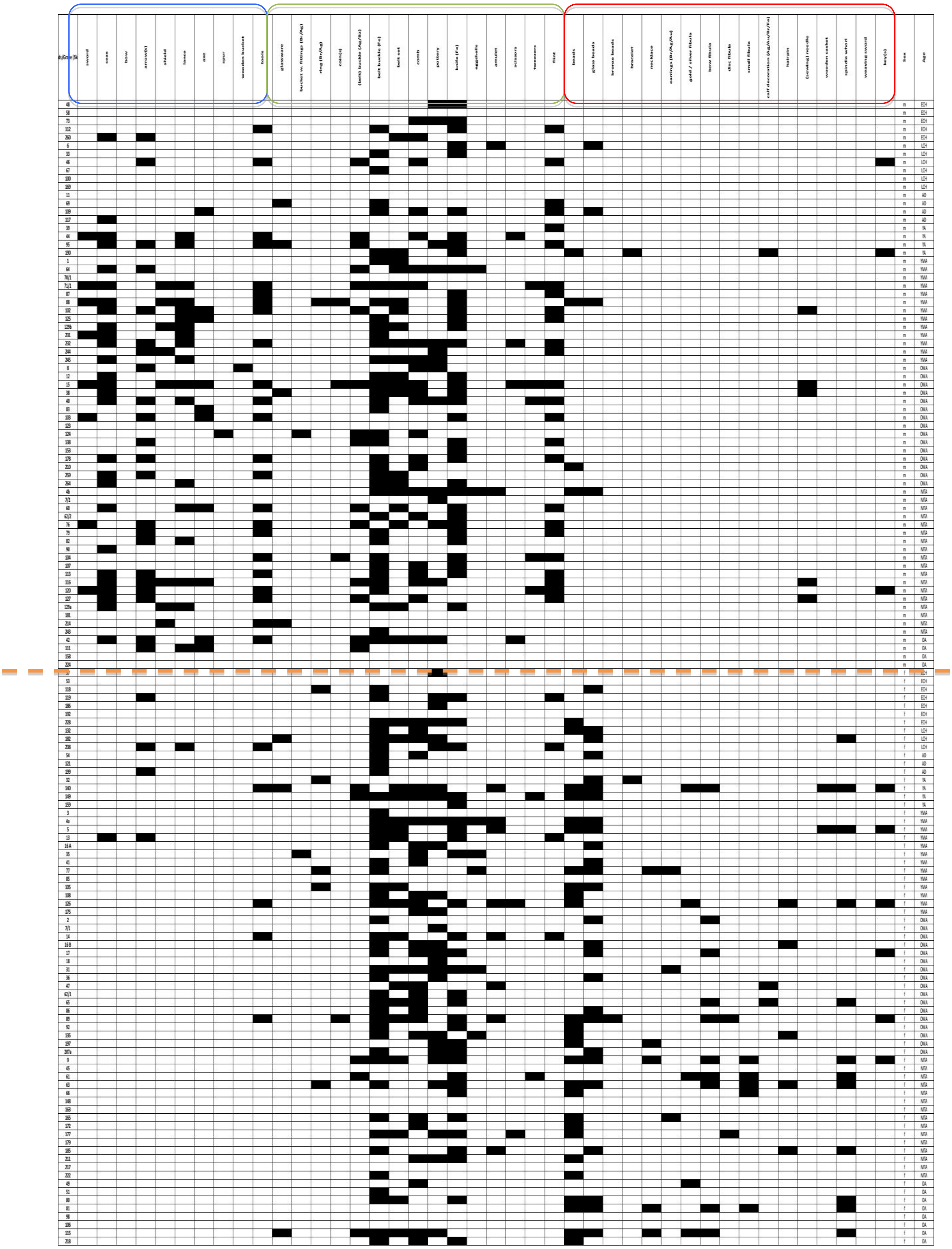


Fig. 5.27: Pleidelsheim - Grave seriation for all intact graves, male and female burials. The dashed line marks the intersection between male and female burials. (A larger version of this figure can be found in App. 5, Fig. 25 - 28.)

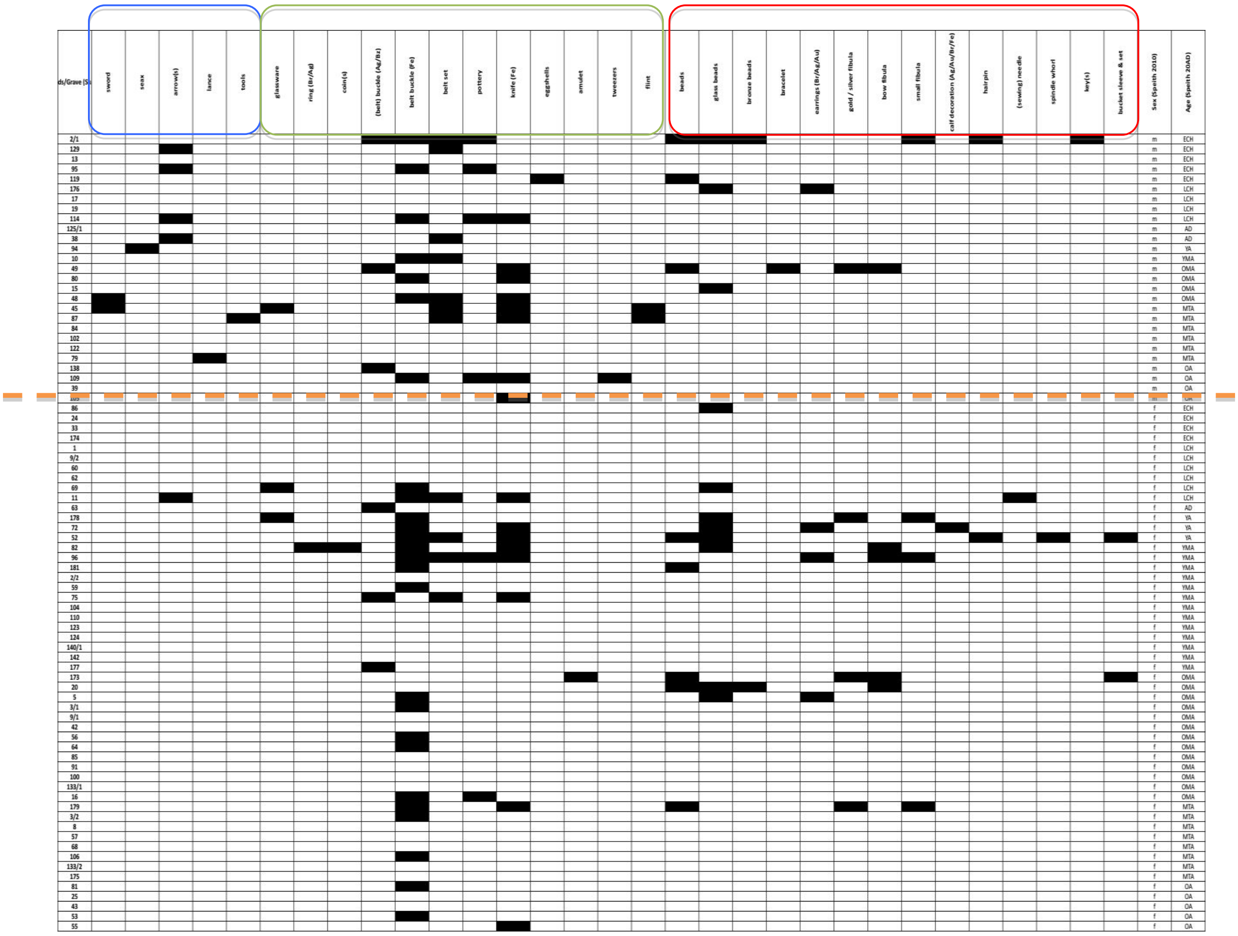


Fig. 5.28: Neresheim - Grave seriation for all intact graves, male and female burials. The dashed line marks the intersection between male and female burials. (A larger version of this figure can be found in App. 5, Fig. 25 - 28.)

In fact, in Pleidelsheim, tendencies in GG assemblages for males and females become visible, yet they remain rather undefined, and scattered distributions of AT signify an unsatisfying pattern regarding the establishment of gendered artefacts or groups thereof. Especially in Neresheim, with fewer intact burials as well as fewer quantities of GG and AT, a pattern in grave good distribution, which consequently could be confidently used for structuring gender and age gradients in these Alamannic burials, remains obscured.

However, the apparent tendencies prompt the re-structuring of AT groups. Instead of a categorization after unsubstantiated preconceptions proposed for Alamannic cemeteries in general and leaning onto the 'male' and 'female kits' proposed by Christlein and, albeit with some objections, followed by archaeologists, AT as found present in the cemeteries of Pleidelsheim and Neresheim can be categorized into large material groups:

- weaponry
- horse riding equipment
- grave furnishing
- personal equipment
- costume attributes & jewellery.

If we look more closely at the artefact distribution for males and females in Pleidelsheim and Neresheim arranged in groups of material culture, we find a much clearer picture regarding gendering of artefact types, explicitly for these two settlements. This approach is also less strongly subject to sample size, especially in the case of Neresheim, which may often be a valid objection to many interpretations from GG and AT in these two cemeteries. Yet structuring patterns emerge even with these small sample sizes and demand explanation.

In Pleidelsheim, the distribution of artefact types between males and females assumes clearly distinguishable patterns (Fig. 5.29). In the category *'weaponry'* (sword - helmet/armour), males show a clear predominance for most items, with sword and axe being exclusively found in male burials and the equipment with seax and arrows being significantly more frequent than in female graves ($p = .000^{**}$), although not exclusively male. The same applies to tools and flint found in the graves (p = .000**).

Females were more frequently buried with amulets (p = .034*) and also show a significant preponderance of beads, especially glass beads, as a grave good (p = .000**).

Items of '*grave furnishing'* (wooden bucket - eggshells), such as glassware or pottery, and from the category '*personal equipment*' (tools - bucket sleeve and set), e.g. belt buckles and sets, combs and iron knives, which might seem predominantly male or female, revealed no statistically significant difference in their distribution. The same applies to previously assumed 'female-gendered' artefacts, now found among '*costume attributes & jewellery*' (beads - (hair-)pin) such as calf decoration and (hair-)pin.

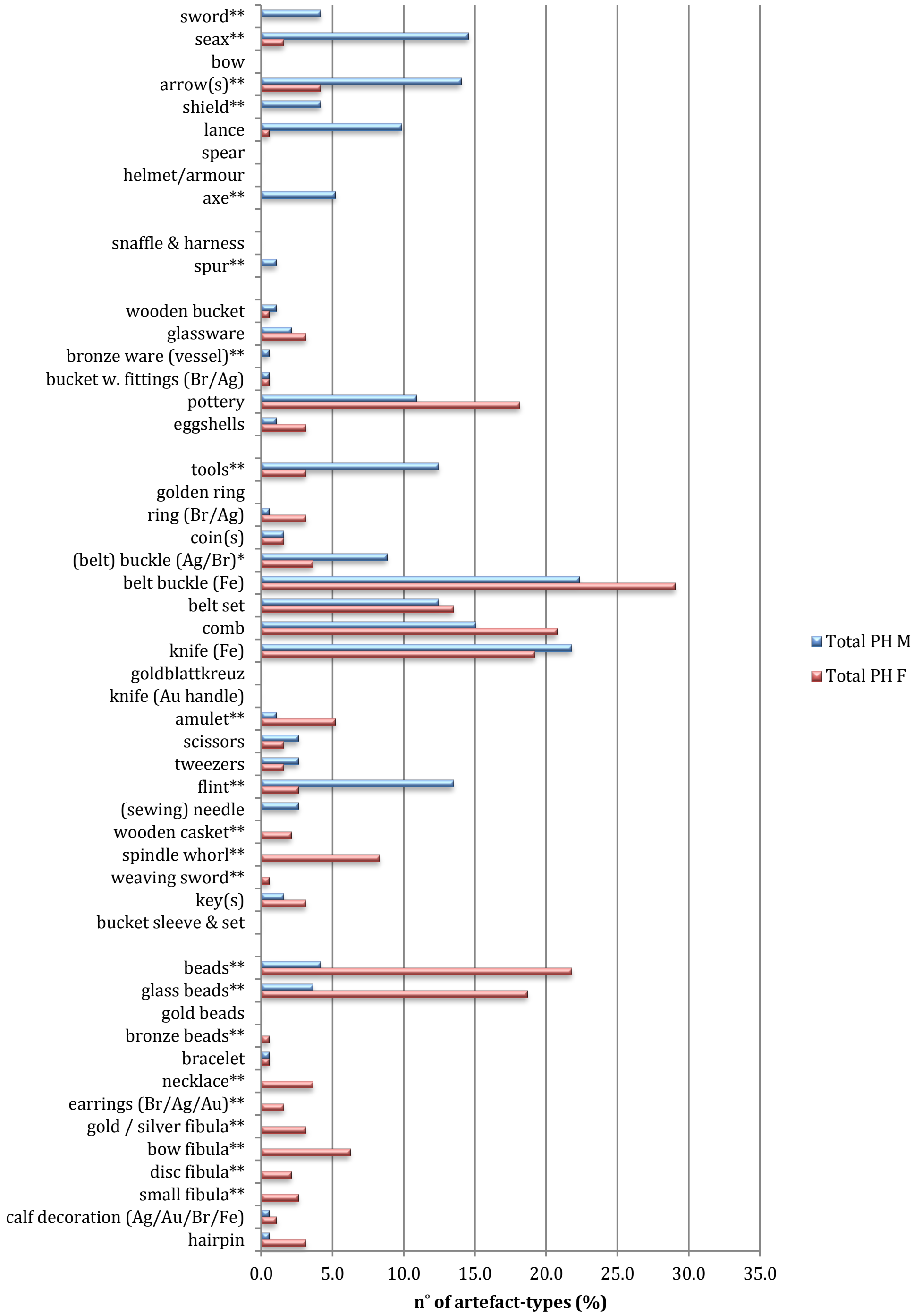


Fig. 5.29: Pleidelsheim - Artefact type distribution for total male and female population (intact graves). Statistically significant differences in quantity between M and F are marked with * (α = .05) / ** (α = .01).

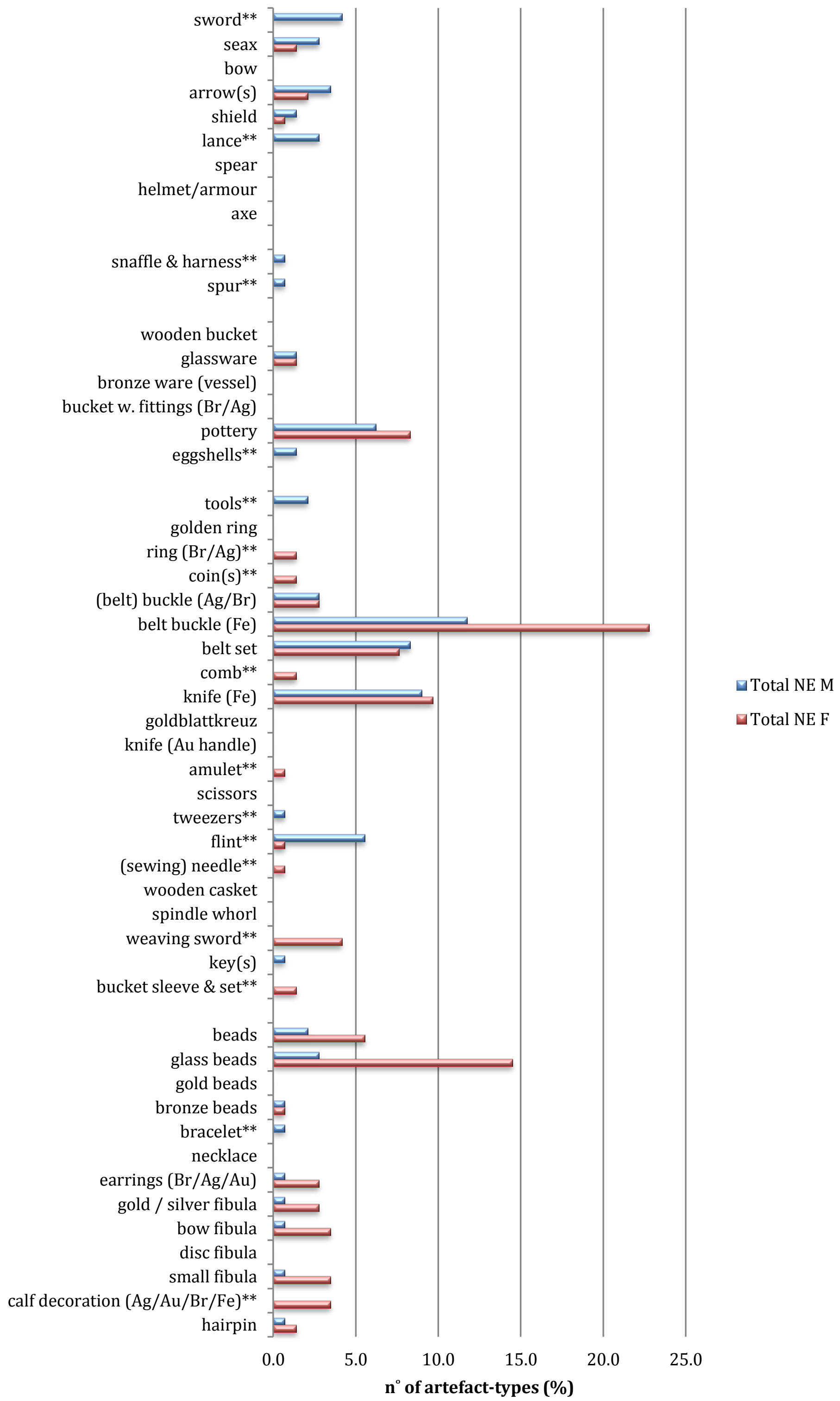


Fig. 5.30: Neresheim - Artefact type distribution for total male and female population (intact graves). Statistically significant differences in quantity between M and F are marked with * (α = .05) / ** (α = .01).

In the burials from Neresheim (Fig. 5.30), only the object ‘flint’ shows a statistically significant frequency in male burials ($p = .000^{**}$), whereas seemingly significantly differing and ‘gendered’ objects such as seax or arrows, but also ‘neutral’ ones such as iron belt buckles show no significant preference as grave object for either sex. Despite the low sample sizes for the different artefacts, it appears that less objects in this cemetery emerge as strongly associated with either male or female burials, an interesting trait regarding the two populations, already indicating a differentiation between them emerging from their mortuary customs, which will become much more apparent with further analysis.

Regarding the artefacts found in the present burials, a new classification of gendered grave goods can be suggested for Pleidelsheim (Table 5.8) and Neresheim (Table 5.9), based on material evidence available in these two cemetery sites, and established *after* biological sex determination as well as testing for significant difference among the artefact types. Not only does this present us with a validated, cemetery-specific review of the artefact patterns of association and possible meaning, it also avoids pre-emptive gendering and enables us to discuss the grave good and artefact type distribution in a manner informed by the archaeological evidence only.

Table 5.8: Pleidelsheim - Gendering of grave goods based on available material evidence: [1] M or F burials only, [2] predominantly in M or F burials, with a statistically significant difference (α = .05), [3] occurring in burials of both M and F, with no significant difference in predominance

exclusively[1] M	*strongly[2] M*	*'neutral'[3]*	*strongly[2] F*	*exclusively[1] F*
weaponry		**grave furnishings**		
sword	seax	wooden bucket		
shield	arrows	glassware		
axe	lance	bucket w. fittings		
		pottery		
	(eggshells)			
horse riding equipment				
spur				
grave furnishings				
bronze ware (vessel)				
personal equipment				
(sewing) needle	tools	ring (Br/Ag)	amulet	wooden casket
bronze vessel	flint	coins		spindle whorl
	(belt) buckle (Ag/Br)	belt buckle (Fe)		weaving sword
		belt set		
		comb		
		knife (Fe)		
		scissors		
		tweezers		
		keys		
costume attributes & jewellery				
		bracelet	beads	bronze beads
		calf decoration	glass beads	necklace
			(hair-)pin	earrings
				fibula (Au/Ag)
				bow fibula
				disc fibula
				small fibula

From the available evidence in Pleidelsheim, we can now confidently consider sword and shield, axe, horse riding equipment (spurs) as well as the artefact type needle as male, with possible additions of seax and arrows (with special considerations which will be discussed subsequently) and lance, as well as tools, flint and a more elaborate belt buckle.

As exclusively female appear wooden caskets as well as weaving swords and spindle whorls, and, from the range of dress and jewellery accoutrement, bronze beads, necklaces, earrings, plus several fibula types. To this can be added the occurrence of amulets, beads, glass beads as well as (hair-)pins.

The whole range of grave furnishings does occur in Pleidelsheim, all objects except for bronze vessels showing 'neutral' connotations. Hitherto 'female' gendered artefacts can be regarded in more equitable light, such as bracelets which might also be understood as an arm ring or similar, or keys / a set of keys, traditionally attributed to women as being those eligible to guard goods kept under lock within the house. However, single keys found associated with males and considered as emblematic for control or authority have already been accepted as male attributes for Alamannic populations (Brather 2008a).

Table 5.9: Neresheim - Gendering of grave goods based on available material evidence: [1] M or F burials only, [2] predominantly in M or F burials, with a statistically significant difference (α = .05), [3] occurring in burials of both M and F, with no significant difference in predominance; * found in a boy's burial, aged to early childhood

exclusively[1] M	*strongly[2] M*	*'neutral'[3]*	*strongly[2] F*	*exclusively[1] F*
weaponry				
sword	shield	seax		
lance		arrows		
horse riding equipment				
snaffle & harness				
spurs				
grave furnishings				
(eggshells)		glassware		
		pottery		
personal equipment				
tools	flint	(belt) buckle (Ag/Br)		(sewing) needle
(key(s))*		belt buckle (Fe)		coins
tweezers		belt set		ring (Br/Ag)
		knife (Fe)		comb
				amulet
				weaving sword
				bucket sleeve & set
costume attributes & jewellery				
bracelet		beads	earrings	calf decoration
		glass beads	small fibula	
		bronze beads	fibula (Au/Ag)	
		(hair)pin	bow fibula	

From the material evidence in Neresheim, we can establish sword and lance, horse riding equipment, tools, as well as tweezers and bracelets and, in addition, possibly shield and flint as male grave attributes. Coins, bronze or silver rings, combs, amulets, (sewing) needle, weaving swords, bucket sleeve and set as well as calf decoration may be considered exclusively female, while earrings and several fibula types can be added to this list. Seax and arrows occur as neutral grave goods, as well as several items of 'personal equipment' and 'costume attributes and jewellery'.

That means two AT out of the category '*weaponry*' seem to have no direct gender-association in Neresheim, as opposed to Pleidelsheim where they occur significantly more in male than in female burials. Tools, however, fall among those artefacts exclusively associated with men, but showing only strong links to male burials in Pleidelsheim.

Impediments associated with textile making (spindle whorls, weaving swords) firmly remain in the female sphere, as do items of dress (especially fibulae) in both cemetery contexts. This is an unsurprising result, since fibulae were a common component of female dress, and comparable to the findings from other Merovingian, Alamannic or Anglo-Saxon cemeteries from the early medieval period (e.g. Stoodley 1999 ; Härke 2000 ; Brather 2004b).

Having established this patterning, it is now possible to explore sex, age and gender identities and trace a life course for the individuals in Pleidelsheim and Neresheim on a much more informed basis, since presumptions are eliminated and the above analyses provides a sound basis on which to proceed.

A note on grave robbery

As the comparatively low numbers of intact burials in both cemeteries suggest, the problem of grave robbery causes serious limitations to the analysis of identities and social structure from material culture in these Alamannic cemeteries and can therefore only offer pieces of information towards these concerns. Causes, mechanisms and consequences of grave robbery in early medieval continental contexts has been discussed at length elsewhere (Kümmel 2009). For this study, it is important to note the amount of grave robbery encountered in Pleidelsheim and Neresheim:

- Pleidelsheim: 32.5 % of all burials,
  28.6 % of male burials,
  31.2 % of female burials.
- Neresheim: 44.2 % of all burials,
  48.2 % of male burials,
  42.7 % of female burials.

For the observation of grave good patterns in relation to the physical evidence in these cemeteries, only the deposition of objects in intact burials can be considered. This excludes some artefacts from the observations but does not necessarily imply these artefacts were not present - especially in Neresheim, it is discernible that it had been exactly those burials once containing more GG and AT that were targeted for removing items and therefore left disturbed[93].

To exemplify this, it means that in Pleidelsheim, there is no evidence of the following artefact types proposed by archaeologists for Alamannic cemeteries: bow, spear, helmet / armour, snaffle / harness, bronze vessel, golden rings, knives with a

[93] Brather (2008a: 165ff.) even suggests the *familia* or village society as having reopened the graves after a while in order to retrieve materials they could not afford to lose forever. This is entirely possible, but cannot be demonstrated in the mortuary contexts at hand.

golden handle, gold beads, bucket sleeve and set. In Neresheim, additionally to most of these objects, there is a lack of spurs, wooden buckets with metal fittings, scissors and disc fibulae, as well as weaving swords in the intact graves.

While items with wooden parts may have fallen victim to degradation (e.g. bows, wooden buckets or caskets), it is rather inconceivable that some items such as disc fibulae, weaving swords or the occasional horse riding equipment and similar materials frequently encountered in Alamannic cemeteries were entirely retained and excluded from the funerary paraphernalia in the cemeteries under study.

These circumstances in the Alamannic cemeteries make it so important to consult the skeletal, physical evidence first and foremost, as the artefactual evidence is heavily distorted, not only by intentionality but by the impediment of grave robbery and disturbance.

Artefact type distribution among Males and Females

The confinement to intact burials for the following analysis of sex, gender and age in relation to the mortuary context results in mostly relatively small sample sizes, especially when breaking down the data into age and gender; however, the emerging pattern deserves attention.

a) Pleidelsheim

A comparison of frequencies of AT deposited in child (ECH and LCH) and adult (AD - OA) graves in Pleidelsheim demonstrates a clear predominance in quantity as well as variety of grave goods in adult burials (Fig. 5.31). While it was possible for adults to be buried with numbers of items exceeding 11 AT, the highest number of AT found in child burials is 7 (cf. also App. 5, Tables 7 and 8).

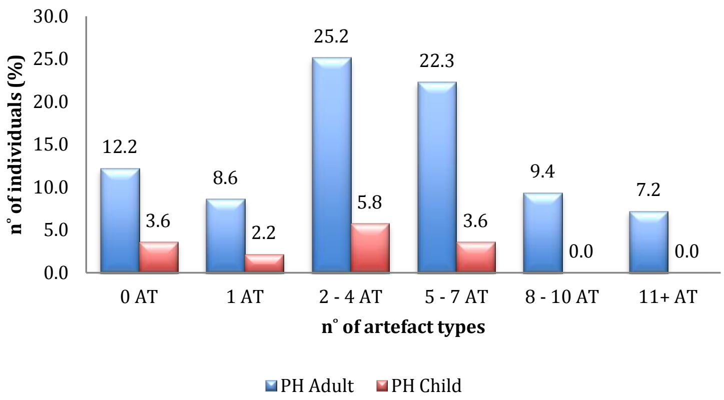


Fig. 5.31: Pleidelsheim - Distribution of artefact types in the population

In subadult burials, both groups, male and female, show an offering of grave goods up to the range of 5 - 7 AT. However, graves of male children display a peak of artefact deposition amounting to 2 - 4 AT, while female children show a clear tendency to having been buried with greater quantities of AT (Fig. 5.32), as well as less often than male subadults without any GG[94].

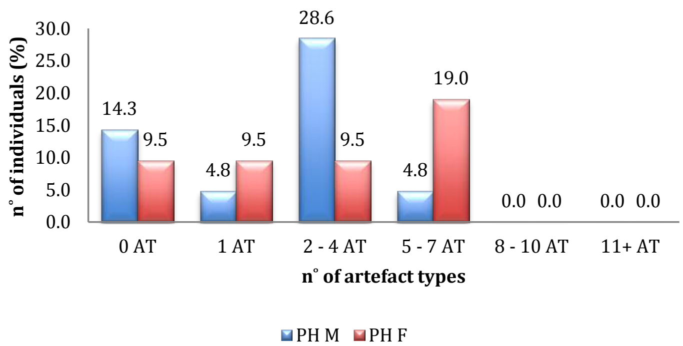


Fig. 5.32: Pleidelsheim - Distribution of artefact types in intact child burials

[94] no statistically significant difference found

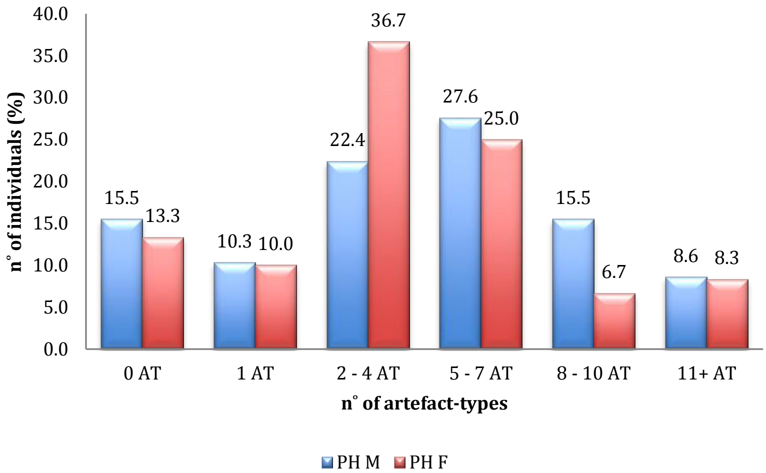


Fig. 5.33: Pleidelsheim - Distribution of artefact types in intact adult burials

The latter trend continues into adulthood (Fig. 5.33): the intact adult burials present a marginally higher prevalence for males having been buried without any GG than for females. Slightly, albeit not significantly, more females than males show GG assemblages in the range of 2 - 4 AT, yet overall, the distribution of artefact deposition is alike for males and females in Pleidelsheim, and we find members of both sexes as recipients of a relatively large wealth and variety of AT and GG in this cemetery (11+ AT, cf. also App. 5, Tables 9 - 12 for details of GG and AT numbers).
One of the 'outliers' seen before in the comparison of GG and AT distribution in the male sample, for instance, is burial 15, an OMA male who was endowed with altogether more than 21 GG and 16 AT, among them the only full set of weaponry found in Pleidelsheim (i.e. five weaponry AT). Among the females, we find cases with similar quantity and variety of GG assemblages in almost all age categories (App. 5, Table 12).

b) Neresheim

In Neresheim, the deposition of GG takes on different patterns (Fig. 5.34).

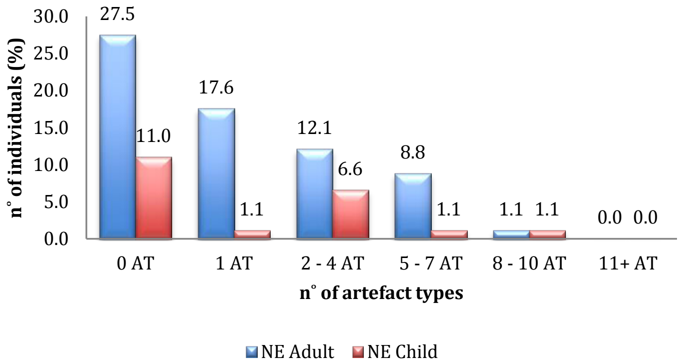


Fig. 5.34: Neresheim - Distribution of artefact types in the population

Here, 27.5 % of adults, but only 11.5 % of subadult graves were completely lacking the deposition of artefacts. Both groups show a possible accumulation of objects up to 8 - 10 AT, however, this is also the highest amount of AT found in the entire cemetery sample. In general, adults do receive more AT than children, who show a 'peak' of quantity at 2 - 4 AT, however, with generally much lower numbers of artefacts than adults.

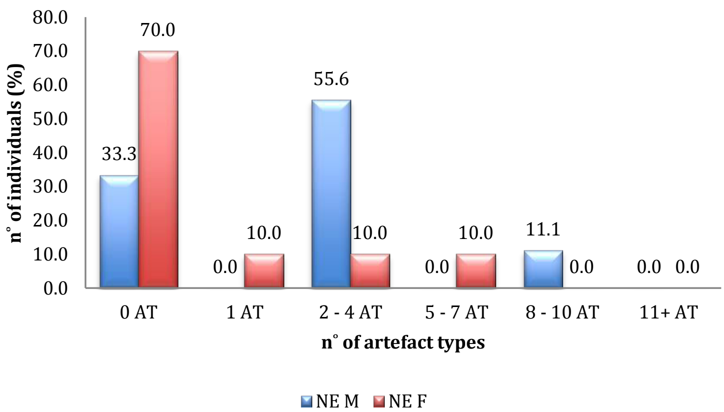


Fig. 5.35: Neresheim - Distribution of artefact types in intact child burials

Regarding subadults (Fig. 5.35), girls were buried without any GG in many more cases[95] than boys, an opposite trend to that observed at Pleidelsheim. As at Pleidelsheim, GG assemblages consisting of 5 - 7 AT are still found in female child burials, yet male children exceed these numbers by receiving the quantity and variety of artefacts (8 - 10 AT) which also constitutes the limit of deposited artefact numbers in Neresheim overall.

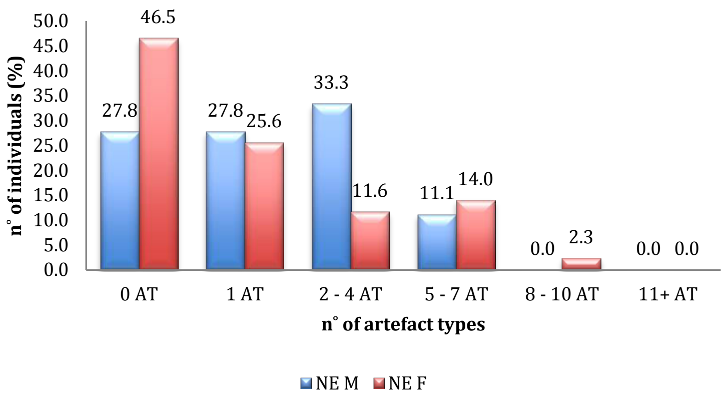


Fig. 5.36: Neresheim - Distribution of artefact types in intact adult burials

This trend for males presenting the highest number of AT is not repeated in the adult burials (Fig. 5.36), as we find exclusively intact female graves with an assemblage of 8 - 10 AT (cf. also App. 5, Tables 17 and 18). Nonetheless, it is evident that, overall, male adults receive more GG than females, who not only more frequently were buried without any GG, but were frequently presented with only 1 AT and often only one object, despite the finding of comparatively high artefact variety.

In a comparison of subadult burials in Pleidelsheim and Neresheim, we can see that the patterns of actual deposition of artefacts do not differ to a great extent in both

[95] not statistically significant

populations (Fig. 5.37). Both groups of children receive an artefactual wealth mostly within the 2 - 4 AT range. However, although people in Neresheim deposited comparatively fewer AT in the graves overall than in Pleidelsheim, children (and especially male children) receive a greater number and variety of objects in Neresheim, a finding that contrasts the fact that compared to Pleidelsheim, they also present a much higher number of subadult burials without any GG.

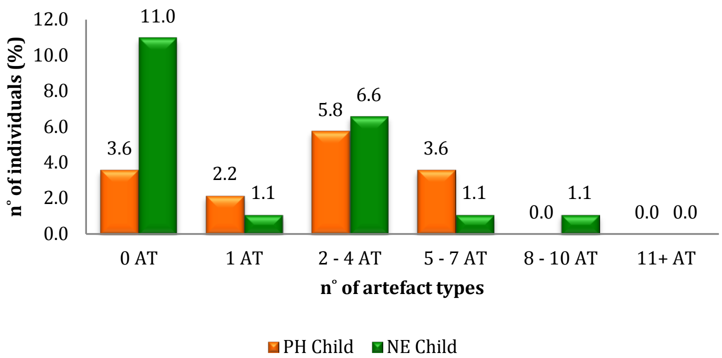


Fig. 5.37: Comparison of artefact distribution in intact child burials at Pleidelsheim and Neresheim

As previously observed, graves in Pleidelsheim exhibit a greater wealth and variety in deposited GG assemblages than those in Neresheim.

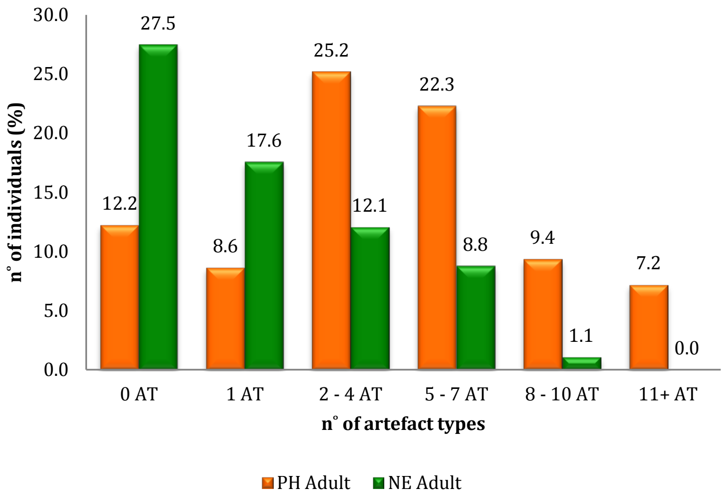


Fig. 5.38: Comparison of artefact distribution in intact adult burials at Pleidelsheim and Neresheim

A direct juxtaposition of the deposition patterns in adult burials in Pleidelsheim and Neresheim (Fig. 5.38) reveals a clear differentiation in mortuary behaviour regarding the provision of GG. In Neresheim, a steadily decreasing number of individuals received an increased number of AT, and with it, GG. While many individuals were buried without any GG, only small numbers received the 'highest' number of AT - adult females and subadult males (Fig. 5.35, Fig. 5.36).

In Pleidelsheim, this distinction is not traceable, and while a good number of graves contained high quantities and a variety of AT, a peak in deposition frequency for this population can be found between 2 - 7 AT (Fig. 5.38).

Grave good distribution by Burial Type

Given the differential results regarding biological sex and interment in the three main burial types in Pleidelsheim and Neresheim (cf. Chapter 5.1.3), it is apposite to complement these findings with an analysis of artefact deposition.

a) *Pleidelsheim*

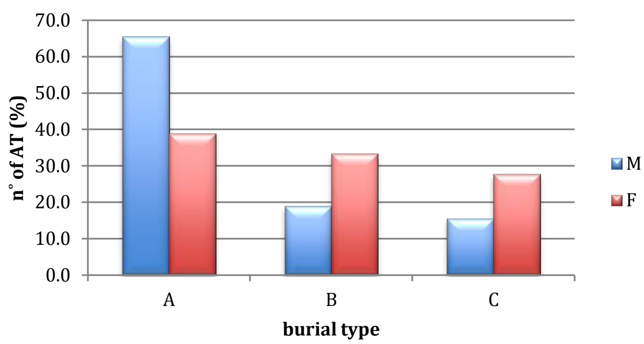


Fig. 5.39: Pleidelsheim - Numbers of artefact types across burial types

While the number of artefact types included in either coffin (type A), simple (type B) or chamber graves (type C) for females in Pleidelsheim remains relatively consistent across the three burial types (Fig. 5.39; cf. App. 5, Table 19), there is a significant difference to be noted between them regarding male burials, with those men buried in coffins receiving considerably more artefact types than those in either of the other two burial types ($p = .000^{**}$, $N = 174$, $\chi = 40.707$). This also constitutes a significant positive difference to the number of grave goods found in female coffin graves ($p = .005^{**}$, $N = 112$, $\chi = 7.954$; cf. App. 5, Table 19), whereas in simple or chamber graves, males and females received a comparative number of grave goods (cf. App. 5, Table 19).

It does concur with the findings made for age and gender in relation to burial types (cf. Chapter 5.1.3): not only were males considerably more often buried in coffins, but those individuals were also bestowed with the highest number of AT.

Noticeable, yet not surprising, is the finding of only up to 10 AT offered in female burials of the simplest style (type B), whereas women buried in coffins or chamber graves received a much greater wealth and array of objects (cf. App. 5, Table 19). In male burials, however, we find the opposite: even more frequently than in coffin or chamber graves, artefacts amounting to more than 11 types could occur in simple burials.

b) *Neresheim*

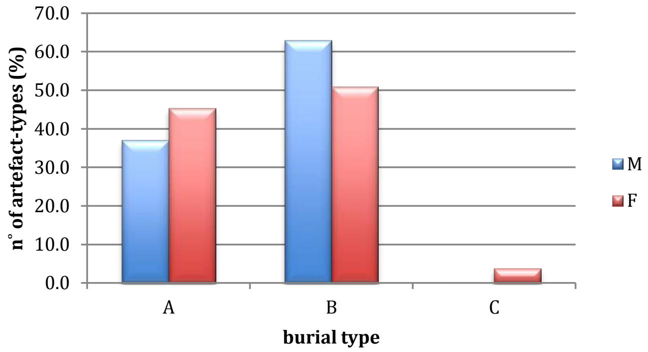


Fig. 5.40: Neresheim - Numbers of artefact types across burial types

In Neresheim, there is a significant difference for females regarding the amount of GG and AT in coffin and simple burials (types A and B) versus chamber graves (type C; Females: $p = .000^{**}$, $N = 159$, $\chi = 31.642$; Fig. 5.40; cf. App. 5, Table 20). We do not have evidence of intact chamber burials for males and therefore cannot draw conclusions regarding the artefact provision, but it is conceivable from the disturbed burials that male chamber graves did contain at least some artefacts (up to 2 AT were found). However, in a notable parallel to Pleidelsheim, we find male graves of the most simple burial style exhibiting up to the highest number of AT (8 - 10) detected in this cemetery.

Female burials, similarly to males, display a concentration of GG in simple graves, however as opposed to males whose grave good assemblage is quantitatively strongest in simple burials, females received an almost equal amount of GG in coffin (45.3%) as in simple graves (50.9%, cf. App. 5, Table 20), as well as the highest quantity and variety of GG (8 - 10 AT) found to be deposited in graves of coffin style. It is noteworthy at this point that among those few females who were granted a burial in a chamber grave in Neresheim (cf. Chapter 5.1.3), a child (ca. 6 - 12 years) shows five artefact types in its burial, while an OMA female shows none. Unfortunately, the other chamber burials could not be assessed for their number of artefacts, as they were not intact.

Attention has also to be drawn to the absence of artefacts from graves in this sample. Not unexpectedly (although interestingly, this not being the case in Pleidelsheim), those males buried in simple graves (type B) also show the highest frequency of complete artefact absence (cf. App. 5, Table 20). Female burials, however, even though they show the same trait, also reveal an almost equal amount of object-less interment in coffin burials, i.e. there is no noticeable difference in GG deposition between the two most common burial modes for females in Neresheim.

All this is suggestive of burial style having influenced artefactual mortuary practice much less, or rather much more diversely, than the constituents of age and gender.

Change with periods in grave good deposition customs

At this point it is worth considering the changes the 6th and 7th centuries AD brought about for the customs of grave good deposition. As pointed out earlier, the periodization of burials in Pleidelsheim and Neresheim is only approximate and lacks any scientific dating (see Chapter 2.2.2), however, a rough categorisation of the available intact burials yields the necessary results on changing patterns from pre- to post-Frankish times.

The samples would become too small when breaking them down not only into periods and sex of the individuals, but also age categories, but details to this effect (all graves and their contents within their chronological setting) can be found in App.

5, Tables 7 - 12 (Pleidelsheim) and 13 - 18 (Neresheim). A closer examination of burials with particularly wealthy grave assemblages resulted in no specific attribution to a period.

In Pleidelsheim, we encounter a pattern of change with time that is familiar from Merovingian contexts (Halsall 1995 ; Steuer 2004): an increase of GG deposition from the 5th to the 6th c. AD, a peak in the 6th c. AD and a subsequent decline in this mortuary practice in the 7th c. AD (Table 5.10; Fig. 5.41). Although there was no indication of Christian influences found in the excavated graves, and it is generally assumed that the settlement was abandoned by the time Christianity found its way into the Alamannic populations (Koch 2001: 353ff.), a gradual decline in artefact deposition is often considered to be connected with the rise of Christianity in Frankish settlement areas.

Table 5.10: Pleidelsheim - Number of grave goods across the centuries

PH	5th c.	6th c.	7th c.	%	5th c.	6th c.	7th c.
M	113	156	57	M	34.7	47.9	17.5
F	70	154	76	F	23.3	51.3	25.3
PH Total	183	310	133	PH Total	29.2	49.5	21.2

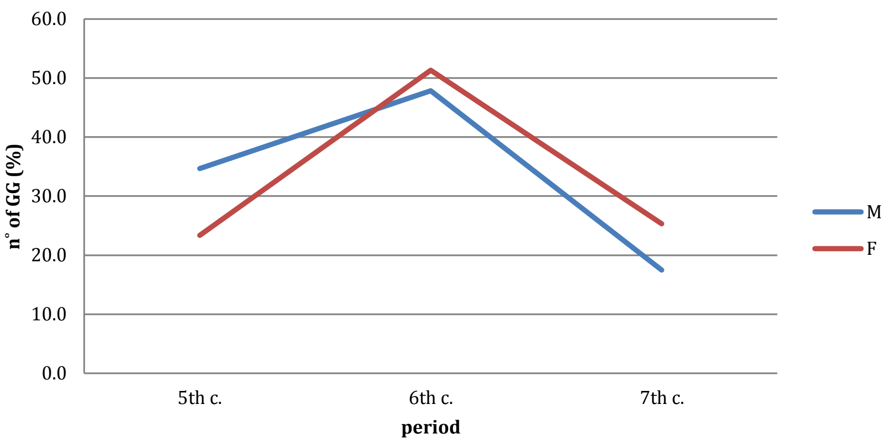


Fig. 5.41: Pleidelsheim - Distribution of grave goods (frequencies) across the centuries

Considering the five major artefact groups in Pleidelsheim separately, it becomes apparent that this development affects all object categories (Fig. 5.42; Fig. 5.43).

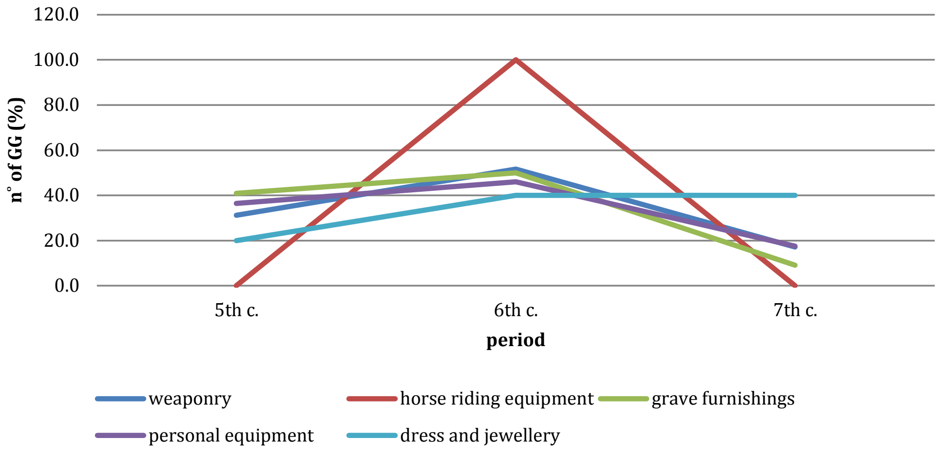


Fig. 5.42: Distribution of artefact groups in Pleidelsheim across the centuries: Male burials

In male burials at Pleidelsheim, horse-riding equipment has only been recovered from a 6th century burial. Items belonging to grave furnishings, personal equipment as well as weaponry, i.e. in regarding the latter a range of male-gendered AT, all undergo a decrease in their frequency as burial goods (Fig. 5.42). The relatively steady occurrence of items belonging to the '*dress and jewellery*' category cannot, due to the limited sample sizes for those items in male burials, be explained further than to the simple fact that these items, as aspects of costume, remained unchanged in their meaning and purpose and therefore as a burial accoutrement.

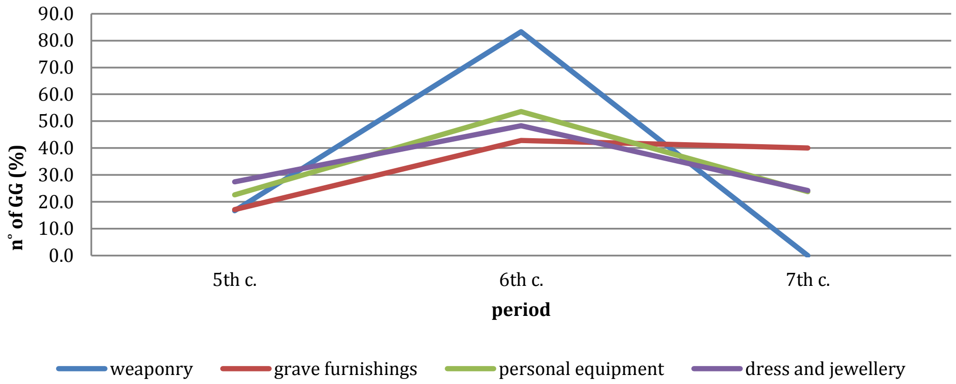


Fig. 5.43: Distribution of artefact groups in Pleidelsheim across the centuries: Female burials

In female burials, we can observe a similar pattern. Seax and arrows, which constitute items of the category '*weaponry*' in female burials in Pleidelsheim, do not occur before the 5th c. AD (cf. also App. 5, Table 10). There is a less strong decrease in items of '*grave furnishing*' in female graves with the 7th c. AD, suggesting that these AT, although entirely 'neutral' as a part of the grave good assemblage, may have assumed an increasingly female symbolism during the 7th century. That means we can discern a possible change in artefactual gender-distinction for a subgroup of artefacts in Pleidelsheim.

In Neresheim, a number of graves could not be definitely attributed to the 5th or 6th c. AD and therefore form a separate subgroup, marking a transition period in the cemetery chronology. We are presented with a contrast to the findings at Pleidelsheim regarding customs of grave good deposition (Table 5.11; Fig. 5.44). Even when disregarding the drop in artefact deposition during the transition from the 5th to the 6th c. AD and taking into account the small number of burials falling into this period, we still witness a decrease instead of an increase of objects buried with the deceased in the 6^{th} c., and an increase in the 7^{th} c. AD, for both males and females.

Table 5.11: Neresheim - Number of grave goods across the centuries

PH	5th c.	$5^{th}/6^{th}$ c.	6th c.	7th c.	%	5th c.	$5^{th}/6^{th}$ c.	6th c.	7th c.
M	20	16	3	16	M	36.4	29.1	5.5	29.1
F	33	0	4	26	F	52.4	0.0	6.3	41.3
PH Total	53	16	7	42	PH Total	44.9	13.6	5.9	35.6

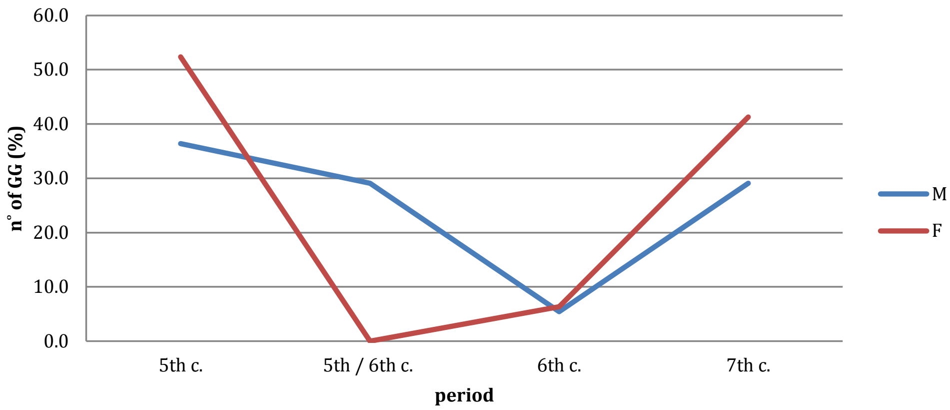


Fig. 5.44: Neresheim - Distribution of grave goods (frequencies) across the centuries

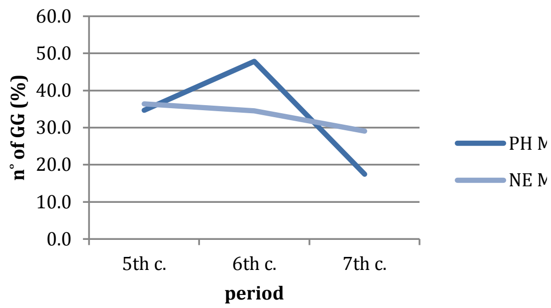


Fig. 5.45: Comparison of grave good distribution across the centuries: Males

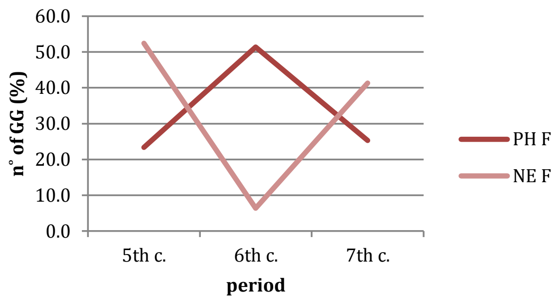


Fig. 5.46: Comparison of grave good distribution across the centuries: Females

In direct comparison with Pleidelsheim and considering the developments over three centuries, it is discernible that it is the female sample that displays a remarkable difference in mortuary behaviour (Fig. 5.46), while the artefact deposition in male burials indeed declines in the 6th c. AD as well, compared to the 5th c., yet echoes the pattern of male burials in Pleidelsheim to a certain extent, even though on a much less obvious scale and with the difference of increasing instead of decreasing GG deposition during the 7th c. AD (Fig. 5.45).

This is especially the case with '*weaponry*' items, which, as opposed to the other three artefact groups, also did not decline in abundance during the 6th c. but remained relatively stable (Fig. 5.47).

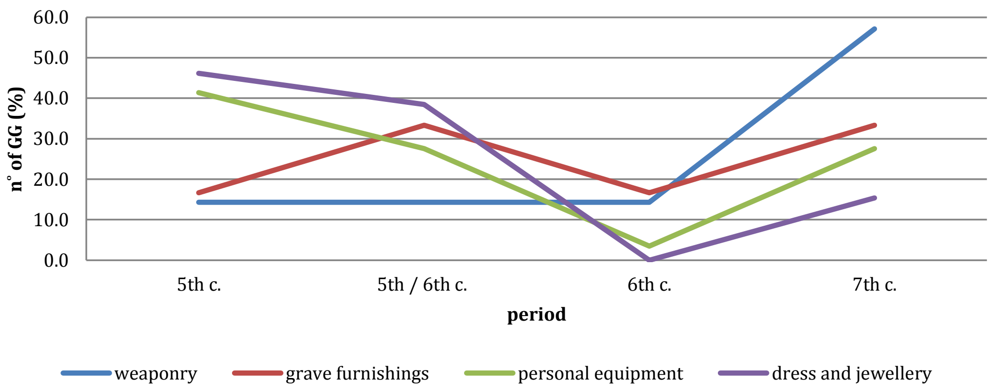


Fig. 5.47: Distribution of artefact groups in Neresheim across the centuries: Male burials

The decline in female grave good assemblages during the 6th c. AD shows especially in the categories 'grave furnishings' and 'personal equipment' (Fig. 5.48). The provision with items of costume and jewellery grows steadily from the turn of the 5th/6th c. AD, the reason for which can be certainly found in these objects being part of prevailing costume habits as well as being strongly associated with female gender. Items from the other artefact categories are gaining prevalence with the 7th c. AD. This applies especially to objects typically falling into the '*weaponry*' category. While arrows were present in female burials from the 5th/6th c. onwards, items such as the seax were exclusively found in burials dating into the 7th. c. in Neresheim (cf. App. 5, Table 18).

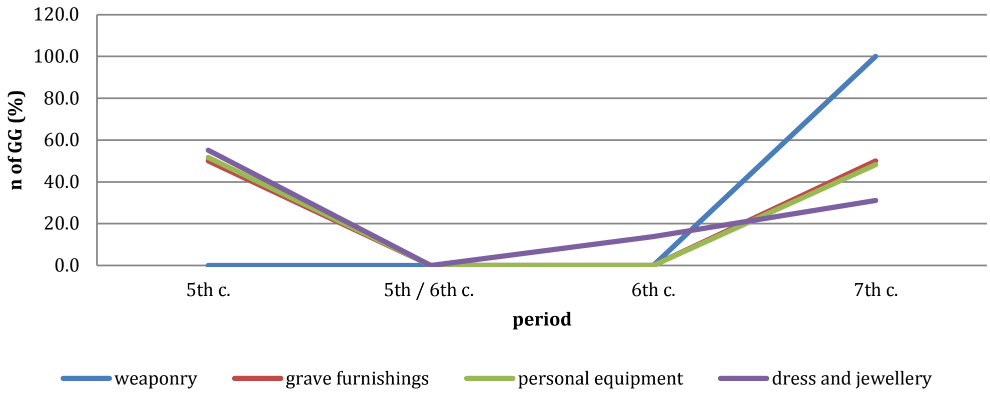


Fig. 5.48: Distribution of artefact groups in Neresheim across the centuries: Female burials

Tracking the behaviour in artefactual deposition customs in Pleidelsheim and Neresheim has thus provided us with another significant piece of information. In Pleidelsheim, we detect an overall increase of GG and gendered AT with the impact of the Frankish rule, and a decline in the course of the 7th c. AD. In Neresheim, and especially regarding women, the contrary seemed to have happened.

These results lead to the question of the life course for individuals in Pleidelsheim and Neresheim, and whether the life course was different for males and females in the two populations under study. Differences with regard to the social significance of individuals within and between the two groups can be anticipated from these findings.

5.2.2 The Influence of Age on Burial

"In terms of how gender is now understood, age is fundamental." (Lucy 2011: 694) Given the unquestionable interrelationships between age, sex and gender identity, it is of crucial importance to take into account biological age as a determining factor in this analysis. The assumption that the burial rite and its components are strongly connected to the age of the deceased seems very obvious, yet up to this point, research focused largely on merely contrasting children and adults. Determining at what age-at-death certain goods were given to the deceased, in what quantity and variability, is essential in order to reconstruct life cycles.

A look at the average numbers of GG and AT in Pleidelsheim and Neresheim confirms previous observations, but even more clearly differentiates between GG and AT (Table 5.12):

Table 5.12: Total averages of grave goods and artefact types in Pleidelsheim and Neresheim

Sex	Average n° of GG (Total)	Average n° of AT (Total)	Sample Size (Total)
		Pleidelsheim	
M	5.3	4.5	69
F	5.2	4.3	70
		Neresheim	
M	2.6	2.1	27
F	1.5	1.4	53

For males, the average number of GG is higher in Pleidelsheim than in Neresheim. The average number of AT is almost halved in Neresheim, and hardly differs for males in this cemetery from the average number of GG, indicating far less variety in object deposition for this population. In Pleidelsheim, males are buried with overall similar numbers of AT as females. In Neresheim, a more noticeable gap can be observed, with clearly more objects reserved for males.

Females in Neresheim exhibit considerably lower numbers of average GG and AT, compared to their counterparts at Pleidelsheim. Further, while in Pleidelsheim the average number of GG is almost equal to the average number of GG for males, females in Neresheim show even fewer GG than males overall.

a) Pleidelsheim

A closer examination of average GG and AT numbers in Pleidelsheim demonstrates how age clearly has an influence on the quantity of artefacts and the wealth of the grave good assemblage overall, as both number of GG and number of AT change depending on age category (Table 5.13). The expressiveness of distributions does not change noticeably when using larger age categories for observing patterns of GG assemblages, as other authors have done; hence, maintaining the chosen, more detailed age categories is justified.

Table 5.13: Pleidelsheim - Grave good and artefact type distribution - Males

Age Category	Average n˚ of GG	Average n˚ of AT	Sample Size
ECH	2.6	2.6	5
LCH	2.8	2.0	6
AD	4.0	2.5	4
YA	7.3	6.3	4
YMA	7.7	5.8	13
OMA	7.4	5.3	15
MTA	7.1	4.4	18
OA	3.5	3.5	4
Average Males	5.3	4.5	69

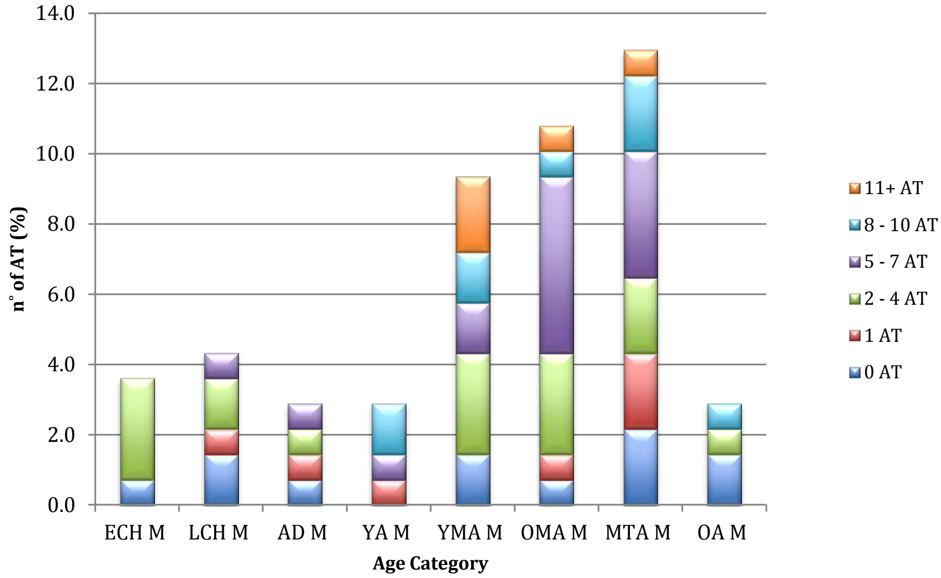


Fig. 5.49: Pleidelsheim - Number of artefact types in intact male burials

Considering male burials, from ECH onwards, the average number of GG as well as AT increases steadily, up to OMA, after which a distinct drop in numbers, especially regarding AT, is visible (Table 5.13; Fig. 5.49).

Considering childhood, LCH M received a greater variety and wealth than ECH M, with the number of GG increasing in burials of AD M.

In the YA M category, all burials were equipped with artefacts, and also up to relatively high numbers (8 - 10 AT). It is at this stage that male burials start to be characterized by wealthy grave good assemblages and an increasing variability in artefact deposition. YMA M to MTA M were the recipients of the greatest range of AT (11+), with a peak of numbers of GG and AT in mature adulthood. After that, a distinct decrease in the number of GG, but also in AT is observable, with OA M only receiving up to 10 AT again, “closing” the bracket of male adulthood which, regarding the grave good assemblage, appears to commence at 18 - 25 years of age

In burials of females at Pleidelsheim, we encounter a similar, although not identical pattern to that noted for males (Table 5.14; Fig. 5.50).

Table 5.14: Pleidelsheim - Grave good and artefact type distribution - Females

Age Category	Average n° of GG	Average n° of AT	Sample Size
ECH	3.1	2.3	7
LCH	8.3	6.0	3
AD	2.7	2.0	3
YA	8.3	6.8	4
YMA	5.0	5.1	13
OMA	5.4	4.7	17
MTA	4.1	3.9	15
OA	4.3	3.9	8
Average Females	5.2	4.3	70

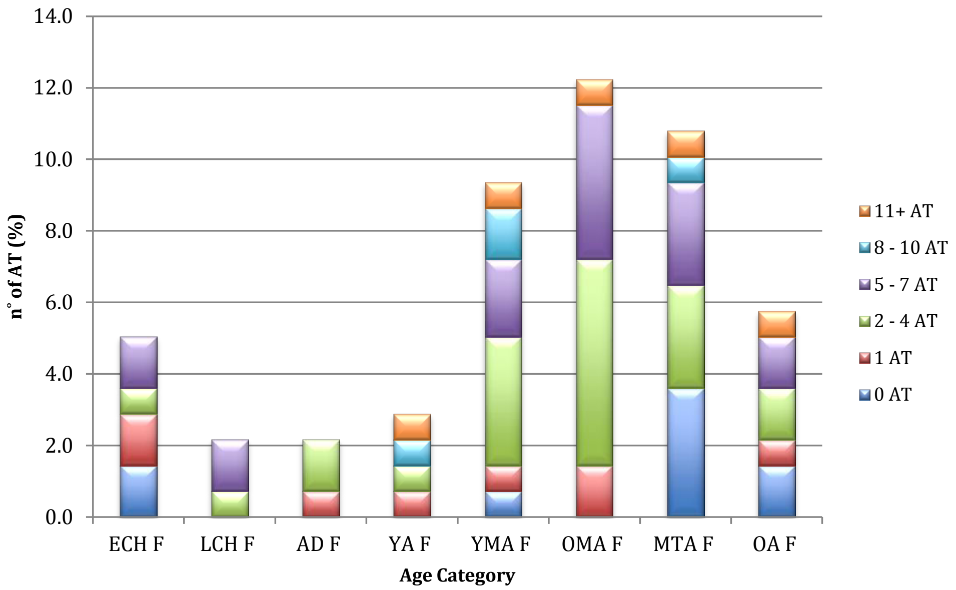


Fig. 5.50: Pleidelsheim - Number of artefact types in intact female burials

Female children in ECH received more GG as well as AT than male children at Pleidelsheim (Fig. 5.49, Fig. 5.50). In LCH, the numbers of AT increased noticeably, something that had been already reported from early Anglo-Saxon cemeteries as well (Stoodley 1999 ; Gowland 2006) for subadults in general. Indeed, the increase in artefact variety (i.e. number of AT) differs significantly from that of LCH (p = .034*), only to then drop below the averages for males again in adolescence.

However, AD and YA, together with later OMA, are the age categories in which no woman was buried without any GG.

Similar to males, the GG assemblage becomes richer with young adulthood, with many females receiving more than 11 AT in their assemblages, and thus more than males of the same age (18 - 25 years). We can follow an increase in GG and AT in the burials from YMA F to MTA F, with a peak in numbers for OMA F, i.e. earlier than for males, but for both cases it should be noted that these are also the age categories with the highest numbers of individuals represented in the Pleidelsheim sample (cf. Chapter 5.1), which adds to a comparatively high number of artefact finds for these categories. Unlike males, females in Pleidelsheim still received high numbers of GG and AT (11 +) when passing away in old age (Fig. 5.50).

Although for both, males and females, numbers of GG and AT increase after young adulthood, a discrepancy in average GG numbers between the two sexes becomes apparent with YMA individuals: male burials maintain relatively high numbers of GG in relation to the respective numbers of AT, but female graves show a decreasing number of GG, much closer to the average number of AT in the respective age category. This strongly suggests that the symbolism of a number of objects deposited in female burials from YMA to MTA was strong enough not to require an increased emphasis by increasing the number of AT, as was the case for certain artefacts in male burials which lead to higher numbers of GG.

This finding does seem obvious, considering the gendered nature of artefacts that women received from young adulthood onwards, i.e. components of dress and jewellery, as will be outlined later in this chapter.

b) Neresheim

The contrasting character of findings from mortuary behaviour in Neresheim is also found with regard to the influence of age, as might be expected. Considering average numbers of GG and AT (Table 5.15), the difference in artefact distribution across the age categories in male burials is conspicuous, an increase from early adulthood onwards up to mature adulthood with a subsequent decrease much less discernible than in male burials from Pleidelsheim.

Table 5.15: Neresheim - Grave good and artefact type distribution - Males

Age Category	Average n˚ of GG	Average n˚ of AT	Sample Size
ECH	5.0	3.4	5
LCH	1.5	1.5	4
AD	1.0	1.0	2
YA	(1.0)	(1.0)	1
YMA	(2.0)	(2.0)	1
OMA	4.5	3.3	4
MTA	1.7	1.7	6
OA	1.5	1.5	4
Average Males	2.6	2.1	27

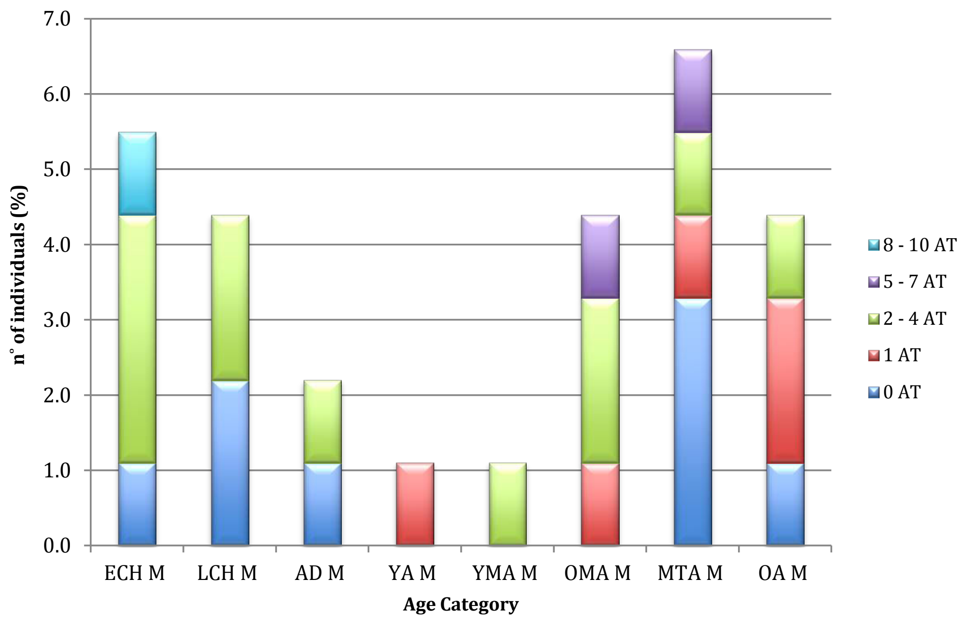


Fig. 5.51: Neresheim - Number of artefact types in intact male burials

It is in ECH among the male burials at Neresheim that we find the distinguishing feature of the highest number of AT (8 - 10) deposited in graves (Fig. 5.51). As observed previously, this constitutes the wealthiest assemblage appearing in the overall sample from Neresheim.

This plummets to a maximum number of four AT in LCH, and further in the burials of AD M (Fig. 5.51; Table 5.15), when not only the number of AT, but also the number of GG is generally low (although note that adolescents are not heavily represented in this sample, cf. App. 5, Tables 15 and 16).

Similarly to male burials at Pleidelsheim, males in the YA category were buried with at least one AT. This figure increases in YMA M burials and reaches a peak in the OMA and MTA categories (Fig. 5.51), when the highest numbers of GG (in OMA M graves) and AT (5 - 7) occur. As at Pleidelsheim, there is a decrease in artefacts for OA M, however, not with such a distinctive demarcation regarding the number of

AT as at Pleidelsheim, for OA M receive a number of GG and AT that is comparable to that noted to occur in childhood. In fact, considering the average numbers of GG and AT (Table 5.15), we can identify a point of decline already just after old middle adulthood (36 - 45 years).

Females in Neresheim received less GG and AT in ECH burials than M, the reverse of what could be observed in Pleidelsheim, but again there are more GG and AT in LCH (Table 5.16; Fig. 5.52). Comparable to Pleidelsheim, females in AD and YA categories were all buried with artefacts, although in fewer numbers, and, likewise, also with fewer AT than AD M.

It is in YA F burials that assemblages with the highest number of AT (8 - 10) are found (Fig. 5.52), the equivalent to ECH M, i.e. the importance of this age category (18 - 25 years) is as noticeable in Neresheim as it is in female burials in Pleidelsheim. YMA F and OMA F see the peak of GG deposition in this sample, with up to seven AT and considerably higher numbers of GG than for males. A decrease in both the number of GG and AT is discernible with MTA. OA F were endowed with only up to one AT, which is distinctly less than OA M and an overt difference to deposition customs in Pleidelsheim, where women passing away in old age were the recipients of even more AT than OA M.

The variety of objects as well as the average quantity of the GG assemblage in young adulthood (Table 5.16) underpins the importance of young women in Neresheim society, much more prominently than it is the case in the Pleidelsheim assemblage, whilst OA females seem to have assumed a quite different role in Neresheim compared to the situation at Pleidelsheim.

Table 5.16: Neresheim - Grave good and artefact type distribution - Females

Age Category	Average n˚ of GG	Average n˚ of AT	Sample Size
ECH	0.3	0.3	4
LCH	1.2	1.3	6
AD	(1.0)	(1.0)	1
YA	7.0	6.0	3
YMA	1.7	1.5	13
OMA	1.5	1.3	13
MTA	0.9	0.9	8
OA	0.6	0.6	5
Average Females	1.5	1.4	53

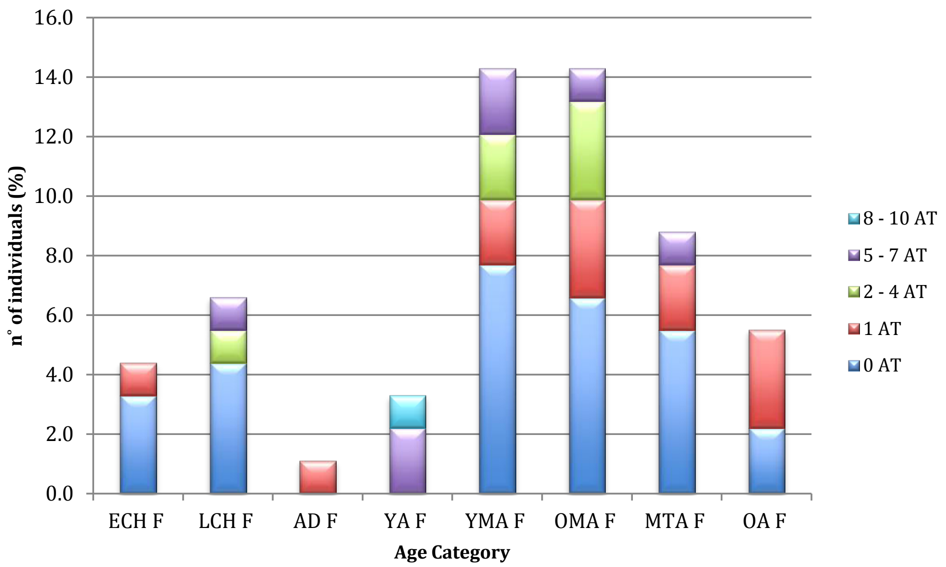


Fig. 5.52: Neresheim - Number of artefact types in intact female burials

Considering the burials from Neresheim overall, the variation between the numbers of GG and numbers of AT is much less pronounced between males and females than at Pleidelsheim (Table 5.15, Table 5.16). This might be due, however, to generally lower numbers of artefacts in the graves in Neresheim. A possible emphasis on male burial accoutrements by repetition after young adulthood, as at Pleidelsheim, is hardly detectable in this sample.

A closer examination of the distribution of separate artefacts and their co-occurrence in assemblages[96] reveals a more comprehensive and meaningful picture of patterns within and between male and female burials in Pleidelsheim and Neresheim.

[96] For these considerations, *all* burials were included in the analysis, for not the composition of an entire assemblage is of relevance, but the attribution of an AT to a certain sex and age group. This explains differing numbers in observations made in intact burials only.

a) Pleidelsheim

Table 5.17: Pleidelsheim - Individual grave good types by age category - Males. Age of onset marked in blue, peaks of distribution marked in orange. Artefacts with singular occurrence are marked with a dotted line.

artefact type	ECH	LCH	AD	YA	YMA	OMA	MTA	OA	Total M
weaponry									
sword	0	0	0	1	3	2	2	0	8
seax	1	0	1	3	8	7	7	1	28
bow	0	0	0	0	0	0	0	0	0
arrow(s)	1	1	0	2	5	7	9	2	27
shield	0	0	0	0	4	1	3	0	8
lance	0	0	0	2	9	3	4	1	19
spear	0	0	0	0	0	0	0	0	0
helmet/armour	0	0	0	0	0	0	0	0	0
axe	0	0	1	0	2	3	2	2	10
horse riding equipment									
snaffle & harness	0	0	0	0	0	0	0	0	0
spur	0	0	0	0	1	1	0	0	2
grave furnishings									
wooden bucket	0	0	0	0	0	2	0	0	2
glassware	0	0	1	1	0	1	1	0	4
bronze ware (vessel)	0	0	0	0	0	1	0	0	1
bucket w. fittings (Br/Ag)	0	0	0	0	0	1	0	0	1
pottery	2	1	0	1	5	4	7	1	21
eggshells	0	0	0	0	1	0	1	0	2
personal equipment									
tools	1	1	0	2	5	5	9	1	24
golden ring	0	0	0	0	0	0	0	0	0
ring (Br/Ag)	0	0	0	0	1	0	0	0	1
coin(s)	0	0	0	0	1	1	1	0	3
(belt) buckle (Ag/Br)	0	1	0	2	4	4	4	2	17
belt buckle (Fe)	1	2	3	1	10	12	12	2	43
belt set	1	0	0	3	10	5	4	1	24
comb	2	1	2	1	6	7	9	1	29
knife (Fe)	3	2	1	3	9	10	13	1	42
goldleaf cross	0	0	0	0	0	0	0	0	0
knife (Au handle)	0	0	0	0	0	0	0	0	0
amulet	0	1	0	0	0	0	1	0	2
scissors	0	0	0	1	1	2	0	1	5
tweezers	0	0	0	0	1	2	2	0	5
flint	1	1	2	2	6	6	8	0	26
(sewing) needle	0	0	0	0	1	2	2	0	5
wooden casket	0	0	0	0	0	0	0	0	0
spindle whorl	0	0	0	0	0	0	0	0	0
weaving sword	0	0	0	0	0	0	0	0	0
key(s)	0	1	0	1	0	0	1	0	3
bucket sleeve & set	0	0	0	0	0	0	0	0	0
costume attributes & jewellery									
beads	1	1	0	1	1	2	2	0	8
glass beads	1	1	1	0	1	1	2	0	7
gold beads	0	0	0	0	0	0	0	0	0
bronze beads	0	0	0	0	0	0	0	0	0
bracelet	0	0	0	1	0	0	0	0	1
necklace	0	0	0	0	0	0	0	0	0
earrings	0	0	0	0	0	0	0	0	0
gold / silver fibula	0	0	0	0	0	0	0	0	0
bow fibula	0	0	0	0	0	0	0	0	0
disc fibula	0	0	0	0	0	0	0	0	0
small fibula	0	0	0	0	0	0	0	0	0
calf decoration	0	0	0	1	0	0	0	0	1
hairpin	0	0	0	0	0	0	1	0	1

Table 5.17 shows the distribution of grave goods in male burials from Pleidelsheim, with the age category of first appearance of an item in the grave good assemblage marked in blue and the peak of distribution marked by orange boxes. Except for horse-riding equipment, we can detect the first appearance of items in every artefact category during ECH, with only three more AT added in LCH (elaborate belt buckle, amulet, keys), expanding the variety of AT in the burials of boys within LCH. However, almost everything deposited within graves of boys deceased in childhood is neutral in character, with the possible exception of tools and flint, as well as seax and arrows, which seem to be predominantly buried with male individuals in Pleidelsheim, although not exclusively so (cf. Table 5.8, Chapter 5.2.1). Moreover, seax and arrows as well as tools occur in male burials at Pleidelsheim up to OA, strongly implying a non-specific aspect to those AT regarding age, sex or status (no preference for these items being deposited in a certain period or burial type could be discerned; see also App. 5, Tables 7 - 12).

There is one sign for engendering GG assemblages in AD, the occurrence of an axe. However, most gendered AT, as identified for this sample in Chapter 5.2.1 (Table 5.8), start appearing in young and young middle adulthood: In the YA category, we find sword and lance among the burial goods; in YMA, this is completed by shield and objects of horse riding equipment (spurs) in the assemblage.

As for most items in the male burials under study, a peak of deposition can be recognized in the age categories YMA - MTA. This also holds true for the ‘neutral’ AT among ‘grave furnishings’ and ‘personal equipment’, as well as for ‘costume and jewellery’: The provision with pottery stretches from ECH to OA, glassware from AD to MTA, and all other items of grave furnishings from YMA up to MTA. Common objects such as belt accessories, comb or knife are found in burials of individuals from ECH to OA, with the more refined silver / bronze belt buckle only appearing in LCH, i.e. at a time when boys also receive an increased number of AT (5 - 7) overall. Elaborate belt buckles are still found in burials of men aged 60+, i.e. in the OA category.

Items such as scissors, tweezers, bronze / silver rings or coins only start appearing in YA M or YMA M burials, and their provision ends with the MTA category. The same applies to the finding of a bracelet and calf decoration. These are singular finds, however, and therefore not very meaningful for this analysis.

With OA M, we therefore find mostly neutral items, although, not exclusively so, considering the occurrence of a lance or tools. That means that men of old age were still buried with a certain amount of gendered AT, complementing a generally wealthy burial mode for that age category and closing the “bracket” in AT provision, with gendered AT beginning in young adulthood or maybe even already in adolescence and presenting full sets of gendered AT in burials within the YMA to MTA categories for males in Pleidelsheim.

Table 5.18: Pleidelsheim - Individual grave good types by age category - Females. Age of onset marked in blue, peaks of distribution marked in orange. Artefacts with singular occurrence are marked with a dotted line.

artefact type	ECH	LCH	AD	YA	YMA	OMA	MTA	OA	Total F
				weaponry					
sword	0	0	0	0	0	0	0	0	0
seax	0	0	0	0	3	0	0	0	3
bow	0	0	0	0	0	0	0	0	0
arrow(s)	2	1	1	0	2	0	1	1	8
shield	0	0	0	0	0	0	0	0	0
lance	0	1	0	0	0	0	0	0	1
spear	0	0	0	0	0	0	0	0	0
helmet/armour	0	0	0	0	0	0	0	0	0
				horse riding equipment					
snaffle & harness	0	0	0	0	0	0	0	0	0
spur	0	0	0	0	0	0	0	0	0
				grave furnishings					
wooden bucket	0	0	0	0	0	1	0	0	1
glassware	1	1	0	1	0	2	0	1	6
bronze ware (vessel)	0	0	0	0	0	0	0	0	0
bucket w. fittings (Br/Ag)	0	0	0	0	1	0	0	0	1
pottery	5	3	0	2	5	11	6	3	35
eggshells	0	0	0	0	3	2	1	0	6
				personal equipment					
tools	0	1	0	1	2	2	0	0	6
golden ring	0	0	0	0	0	0	0	0	0
ring (Br/Ag)	1	0	0	1	2	0	2	0	6
coin(s)	1	0	0	0	1	1	0	0	3
(belt) buckle (Ag/Br)	0	1	0	2	1	0	2	1	7
belt buckle (Fe)	3	3	3	2	17	15	8	5	56
belt set	1	2	0	2	8	7	4	2	26
comb	2	3	1	2	11	10	8	3	40
knife (Fe)	2	2	0	2	7	10	11	3	37
goldleaf cross	0	0	0	0	0	0	0	0	0
knife (Au handle)	0	0	0	0	0	0	0	0	0
amulet	1	0	0	1	3	4	1	0	10
scissors	0	0	0	0	1	1	1	0	3
tweezers	0	0	0	1	1	0	1	0	3
flint	1	1	0	0	1	1	1	0	5
(sewing) needle	0	0	0	0	0	0	0	0	0
wooden casket	0	0	0	1	1	1	0	1	4
spindle whorl	0	1	0	1	2	3	6	3	16
weaving sword	0	0	0	0	0	1	0	0	1
key(s)	0	0	0	1	2	2	1	0	6
bucket sleeve & set	0	0	0	0	0	0	0	0	0
				costume attributes & jewellery					
beads	2	2	1	2	11	6	11	7	42
glass beads	1	2	2	4	9	9	4	5	36
gold beads	0	0	0	0	0	0	0	0	0
bronze beads	0	0	0	0	0	1	0	0	1
bracelet	0	0	0	1	0	0	0	0	1
necklace	1	1	0	0	1	1	1	2	7
earrings	0	0	0	0	1	1	1	0	3
gold / silver fibula	0	0	0	1	1	0	2	2	6
bow fibula	0	0	0	1	0	6	3	2	12
disc fibula	0	0	0	0	0	2	2	0	4
small fibula	0	0	0	0	0	0	4	1	5
calf decoration	0	0	0	0	0	2	0	0	2
hairpin	0	0	0	0	1	2	2	1	6

The distribution of GG and artefact groups in female burials in Pleidelsheim is shown in Table 5.18. Once more, we can observe the first appearance of many AT, especially from the range '*personal equipment*', in the ECH category. Arrows occur in burials of female individuals from ECH onwards up to old age, confirming the previous impression of this AT having no specific age-related connotation. With LCH, a single lance head appears as a GG, and, much more importantly, tools, elaborate belt buckles, as well as spindle whorls. Whereas higher quality belt buckles show similar tendencies in artefactual meaning suggested by its appearance in male burials in Pleidelsheim (also in female burials, it occurs up to old age), the appearance of spindle whorls in female LCH burials can be considered as a sign of engendering childhood in Pleidelsheim, although this artefact could not be found in burials of adolescents. Clearly gendered artefacts (cf. Table 5.8, Chapter 5.2.1), however, start to appear with the YA category and show a peak from YMA - MTA burials: gold / silver fibulae and bow fibulae, items belonging to adult dress but also, in the first case, being of more elaborate making, appear in young adulthood, as does the artefact 'wooden casket'. For many other items that may have occurred at a younger age already, there is a surge with young middle adulthood. It is at this stage when the seax can also be found among the GG assemblage, indicating its possible meaning not as an item of weaponry, but likely as a practical tool for the Alamanni.

Similarly to males at Pleidelsheim, a whole range of objects, including the 'neutral' belt accessories, comb and knife, objects of 'personal equipment' as well as 'grave furnishings', but also engendered spindle whorls or items of dress and jewellery, remain parts of the GG assemblage up into old age, contributing to the variety of AT in the burials of OA F in Pleidelsheim.

Overall, the pattern of artefact distribution in numbers, variety and character follows that of males in this cemetery, with a change in GG deposition with the onset of adulthood that stretches through to old age, when females are endowed with even more variety than males, including seemingly more precious items, as well as those strongly associated with female gender.

b) Neresheim

Table 5.19: Neresheim - Individual grave good types by age category - Males. Age of onset marked in blue, peaks of distribution marked in orange. Artefacts with singular occurrence are marked with a dotted line.

artefact type	ECH	LCH	AD	YA	YMA	OMA	MTA	OA	Total M
				weaponry					
sword	0	0	0	0	1	2	3	0	6
seax	0	0	0	1	1	0	1	1	4
bow	0	0	0	0	0	0	0	0	0
arrow(s)	2	1	1	1	0	0	0	0	5
shield	0	0	0	0	1	0	1	0	2
lance	0	0	0	0	1	0	3	0	4
spear	0	0	0	0	0	0	0	0	0
helmet/armour	0	0	0	0	0	0	0	0	0
				horse riding equipment					
snaffle & harness	0	0	0	0	1	0	0	0	1
spur	0	0	0	0	1	0	0	0	1
				grave furnishings					
wooden bucket	0	0	0	0	0	0	0	0	0
glassware	0	1	0	0	0	0	1	0	2
bronze ware (vessel)	0	0	0	0	0	0	0	0	0
bucket w. fittings (Br,	0	0	0	0	0	0	0	0	0
pottery	2	1	0	0	1	1	3	1	9
eggshells	1	0	0	1	0	0	0	0	2
				personal equipment					
tools	0	0	0	0	1	1	1	0	3
golden ring	0	0	0	0	0	0	0	0	0
ring (Br/Ag)	0	0	0	0	0	0	0	0	0
coin(s)	0	0	0	0	0	0	0	0	0
(belt) buckle (Ag/Br)	1	0	0	1	0	1	0	1	4
belt buckle (Fe)	2	2	0	0	2	4	5	2	17
belt set	2	0	1	0	1	2	5	1	12
comb	0	0	0	0	0	0	0	0	0
knife (Fe)	0	1	0	1	1	5	3	2	13
goldleaf cross	0	0	0	0	0	0	0	0	0
knife (Au handle)	0	0	0	0	0	0	0	0	0
amulet	0	0	0	0	0	0	0	0	0
scissors	0	0	0	0	0	0	0	0	0
tweezers	0	0	0	0	0	0	0	1	1
flint	0	0	0	2	1	2	3	0	8
(sewing) needle	0	0	0	0	0	0	0	0	0
wooden casket	0	0	0	0	0	0	0	0	0
spindle whorl	0	0	0	0	0	0	0	0	0
weaving sword	0	0	0	0	0	0	0	0	0
key(s)	1	0	0	0	0	0	0	0	1
bucket sleeve & set	0	0	0	0	0	0	0	0	0
				costume attributes & jewellery					
beads	2	0	0	0	0	1	0	0	3
glass beads	1	1	0	0	0	2	0	0	4
gold beads	0	0	0	0	0	0	0	0	0
bronze beads	1	0	0	0	0	0	0	0	1
bracelet	0	0	0	0	0	1	0	0	1
necklace	0	0	0	0	0	0	0	0	0
earrings	0	1	0	0	0	0	0	0	1
gold / silver fibula	0	0	0	0	0	1	0	0	1
bow fibula	0	0	0	0	0	1	0	0	1
disc fibula	0	0	0	0	0	0	0	0	0
small fibula	1	0	0	0	0	0	0	0	1
calf decoration	0	0	0	0	0	0	0	0	0
hairpin	1	0	0	0	0	0	0	0	1

In Neresheim, the distribution of artefacts across the life course highlights interesting differences for males and females in this population, compared to those from Pleidelsheim. As noted before, boys buried in ECH received the highest number of AT among the male population in Neresheim (cf. Fig. 5.51). A look at the details of GG in male graves at Neresheim (Table 5.19) reveals that this variety does not include gendered objects (cf. Table 5.9, Chapter 5.2.1), but more often neutral items such as pottery (occurring from ECH to OA), belt accessories (including elaborate silver / bronze belt buckles that also re-occur up until old age), or beads, among which we find bronze beads in this sample. With LCH, knives and glassware appear, also to be placed into the 'neutral' artefact category; however, there is a previously described decline in the variety of AT, and also, as can be seen now, in the nature of artefacts themselves, since more supposedly precious items could be listed for GG assemblages in the ECH category.

In adolescence, no change in depositional behaviour is traceable, and for young adulthood, it is merely notable that the provision of arrows as a GG suddenly ceases, in contrast to what has been observed for males and females in Pleidelsheim. Flint as a grave object appears at this age, as well as the seax, adding to the assemblage of 'neutral' artefacts.

In the male population in this cemetery, it is with YMA that we see the first appearance of gendered AT: sword, lance and horse equipment emerge, as well as shield and tools. It is noteworthy that YMA is also the only age category for the co-occurrence of most of these items, i.e. we can observe the full complement of gendered AT within the age category of ca. 26 - 35.

Despite the low number of artefacts observable for Neresheim, there is an increase for a number of items up to mature adulthood, including sword and lance, however, followed by a sudden decrease to a complete lack of AT except for belt buckles, knives and tweezers, the latter occurring solely in the burial of an OA M. This means with old age, the GG assemblage loses all gendered artefacts; men retain one comparatively elaborate object, the as 'neutral' categorised bronze / silver belt buckle.

Table 5.20: Neresheim - Individual grave good types by age category - Females. Age of onset marked in blue, peaks of distribution marked in orange. Artefacts with singular occurrence are marked with a dotted line.

artefact type	ECH	LCH	AD	YA	YMA	OMA	MTA	OA	Total F
				weaponry					
sword	0	0	0	0	0	0	0	0	0
seax	0	0	1	0	0	0	1	0	2
bow	0	0	0	0	0	0	0	0	0
arrow(s)	0	1	0	0	1	0	1	0	3
shield	0	0	0	0	0	1	0	0	1
lance	0	0	0	0	0	0	0	0	0
spear	0	0	0	0	0	0	0	0	0
helmet/armour	0	0	0	0	0	0	0	0	0
				horse riding equipment					
snaffle & harness	0	0	0	0	0	0	0	0	0
spur	0	0	0	0	0	0	0	0	0
				grave furnishings					
wooden bucket	0	0	0	0	0	0	0	0	0
glassware	0	1	0	1	0	0	0	0	2
bronze ware (vessel)	0	0	0	0	0	0	0	0	0
bucket w. fittings (Br/Ag)	0	0	0	0	0	0	0	0	0
pottery	0	0	0	1	5	2	4	0	12
eggshells	0	0	0	0	0	0	0	0	0
				personal equipment					
tools	0	0	0	0	0	0	0	0	0
golden ring	0	0	0	0	0	0	0	0	0
ring (Br/Ag)	0	0	0	0	1	1	0	0	2
coin(s)	0	0	0	0	2	0	0	0	2
(belt) buckle (Ag/Br)	0	0	1	0	3	0	0	0	4
belt buckle (Fe)	0	2	2	4	7	8	7	3	33
belt set	0	1	1	1	3	2	3	0	11
comb	0	0	0	1	0	0	1	0	2
knife (Fe)	0	1	0	3	4	3	2	1	14
goldleaf cross	0	0	0	0	0	0	0	0	0
knife (Au handle)	0	0	0	0	0	0	0	0	0
amulet	0	0	0	0	0	1	0	0	1
scissors	0	0	0	0	0	0	0	0	0
tweezers	0	0	0	0	0	0	0	0	0
flint	0	0	0	0	0	0	1	0	1
(sewing) needle	0	1	0	0	0	0	0	0	1
wooden casket	0	0	0	0	0	0	0	0	0
spindle whorl	0	0	0	0	0	0	0	0	0
weaving sword	0	0	1	2	2	0	1	0	6
key(s)	0	0	0	0	0	0	0	0	0
bucket sleeve & set	0	0	0	1	0	1	0	0	2
				costume attributes & jewellery					
beads	0	0	1	1	1	2	3	0	8
glass beads	1	1	1	4	4	5	5	0	21
gold beads	0	0	0	0	0	0	0	0	0
bronze beads	0	0	0	0	0	1	0	0	1
bracelet	0	0	0	0	0	0	0	0	0
necklace	0	0	0	0	0	0	0	0	0
earrings	0	0	0	1	2	1	0	0	4
gold / silver fibula	0	0	0	1	0	2	1	0	4
bow fibula	0	0	0	0	3	2	0	0	5
disc fibula	0	0	0	0	0	0	0	0	0
small fibula	0	0	0	2	1	0	2	0	5
calf decoration	0	0	0	2	1	1	1	0	5
hairpin	0	0	0	1	1	0	0	0	2

Regarding female burials in Neresheim (Table 5.20), there are no other AT to be found in ECH than glass beads, which are strongly, but not exclusively, associated with females in this cemetery (cf. Table 5.9, Chapter 5.2.1). As observed earlier, females in Neresheim received more GG and AT with LCH (Fig. 5.52), among which can be counted belt accessories (in simple style) and knives, both also forming the only objects still present in burials of OA F, as well as arrows, all 'neutral' AT, and the (sewing) needle, possibly associated with females in this cemetery but only occurring once in a child's burial.

Interestingly, beads, in all other cases occurring during childhood, only appear with AD F burials in Neresheim. The same applies to the seax ('neutral' AT), weaving sword (female-gendered AT) and the more elaborate belt buckle, conferring more importance to this age category in female burials than was the case in Pleidelsheim.

With young adulthood, we can observe the full onset of gendered objects, including most items belonging to '*costume and jewellery'*, e.g. earrings and fibulae, but also bucket sleeve and set, calf decoration or combs. Even AT such as pottery only start to be provided at this age in this sample. As described earlier, YA is also the category with most AT (8 - 10) in the female sample from Neresheim, signifying an important threshold with the age of ca. 18 - 25, somewhat earlier than for females in Pleidelsheim.

In burials falling into the middle adult category (YMA and OMA), we can discern an increase for most items from the female GG assemblage, only to then witness a decline with mature adulthood, and with it, the end of the provision of gendered GG in female burials in Neresheim.

In general, not only do we observe a differential investment in children of both sexes in Pleidelsheim and Neresheim, but also differing patterns in the provision and composition of grave good assemblages for adults in both cemeteries, which point to a significant variance in, and even contrasting structures of, life course and social significance of males and females in these two Alamannic populations and societies.

5.3 Weapon burials - The archaeological evidence

The 'weapon burial' constitutes an important part of the discussion and identification of male identity in early medieval societies and was a common practice amongst the burials in Pleidelsheim and Neresheim, as the results in Chapter 5.2 indicate.

Several authors, among them especially Härke (1990; 1992; 1997c), emphasized in numerous works similar weapon burial traditions in early medieval cemeteries. These may not represent 'warrior burials', against often repeated opinion, but rather symbolize different aspects of social identity and standing, including facets of age and gender reflected in the burial (Härke 1992). Therefore, it is constructive to the present study to elaborate upon some aspects of weapon burials in Pleidelsheim and Neresheim in more detail.

Note that when considering intact burials, all results are measured on the basis of the weapon finds included in those burials. More or other weapon assemblages have certainly occurred, as the inclusion of materials from disturbed burials in this study elsewhere suggests (for instance, cf. Chapter 5.2, Tables 5.17 - 5.20), but for the analysis of assemblages and their meanings, only intact burials were considered at this point.

5.3.1 Distribution of weapon types

Considering burials in Pleidelsheim,

- graves with 1 weapon type comprise 17.5 %,
- graves with 2 weapon types comprise 19.3 %,
- graves with 3 weapon types comprise 21.1 %,

- graves with 4 weapon types comprise 5.3 %,
- graves with 5 weapon types (i. e a full set) comprise 3.5 %

of the total number of intact male graves.

Some 1.7 % of all intact female burials contain items of weaponry, consisting of one case (Skel. n˚ 13, YMA) with a seax as well as arrowheads, and another one with arrows as grave goods (Skel. n˚199, AD) (cf. App. 5, Tables 10 and 12).

In Neresheim,

- graves with 1 weapon type comprise 23.5 %,
- graves with 2 weapon types comprise 5.9 %

of the total number of intact male graves.

No weaponry was found in intact F burials; however, the occurrence of seax and arrows in other, disturbed female burials has been described in Chapter 5.2 (Table 5.20).

As demonstrated in Table 5.21 and Fig. 5.53, the by now familiar pattern of considerably more AT in Pleidelsheim also applies to individual artefacts within the material group '*weaponry*'. Especially seax, arrows and lance[97] occur in considerably higher abundance in the Pleidelsheim sample (however, only with regard to seax deposition is the difference highly statistically significant, with $p = .000^{**}$, $\chi = 12.967$, $df = 1$).

[97] No spear heads or helmets / armour were found in either Pleidelsheim or Neresheim (Koch 2001; Knaut 1993), however, they do occur in other Alamannic and early medieval cemeteries and were therefore included in the present register in order to draw attention to their absence in these assemblages. Bows might have existed, but due to the organic nature of their components (one preserved example was found in a burial in Oberflacht (Grave 21) (Schiek 1992)) did not survive in Pleidelsheim or Neresheim.

Table 5.21: Numbers of weapon types in Pleidelsheim and Neresheim

	sword	seax	bow	arrow(s)	shield	lance	spear	axe	Total n° of weaponry	Sample size
PH	8	31	0	35	8	20	0	10	112	193
NE	6	6	0	8	3	4	0	0	27	145
					Frequencies (%)					
PH	4.1	16.1	0.0	18.1	4.1	10.4	0.0	5.2	58.0	-
NE	4.1	4.1	0.0	5.5	2.1	2.8	0.0	0.0	18.6	-

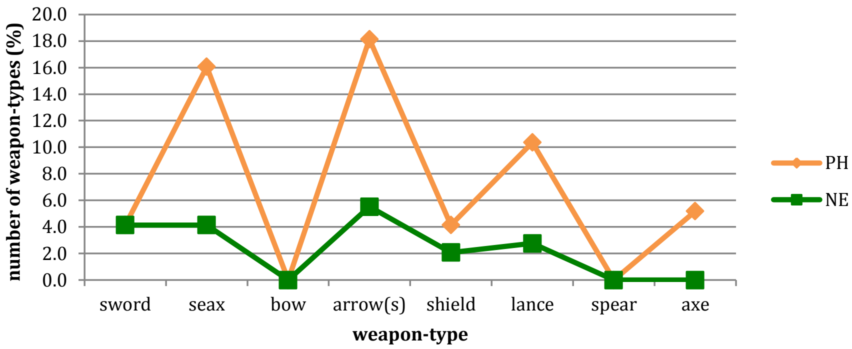


Fig. 5.53: Frequency of weapon types in Pleidelsheim and Neresheim

The arrangement by age category proves coherent (Fig. 5.54): In Neresheim, male burials are found to exhibit lower quantities of weapon artefacts, predominantly apparent in adulthood, than those at Pleidelsheim, where items of weaponry can be observed for every age category from childhood to old age, with an increase and peak from young to old adulthood.

Regarding females, weapon types comprise arrows and seax, which in Pleidelsheim appear in all age categories, while only in the categories AD, OMA and MTA in Neresheim. Given the very small numbers of weaponry items, weapon burials of males and females in Pleidelsheim and Neresheim can be grouped and considered jointly.

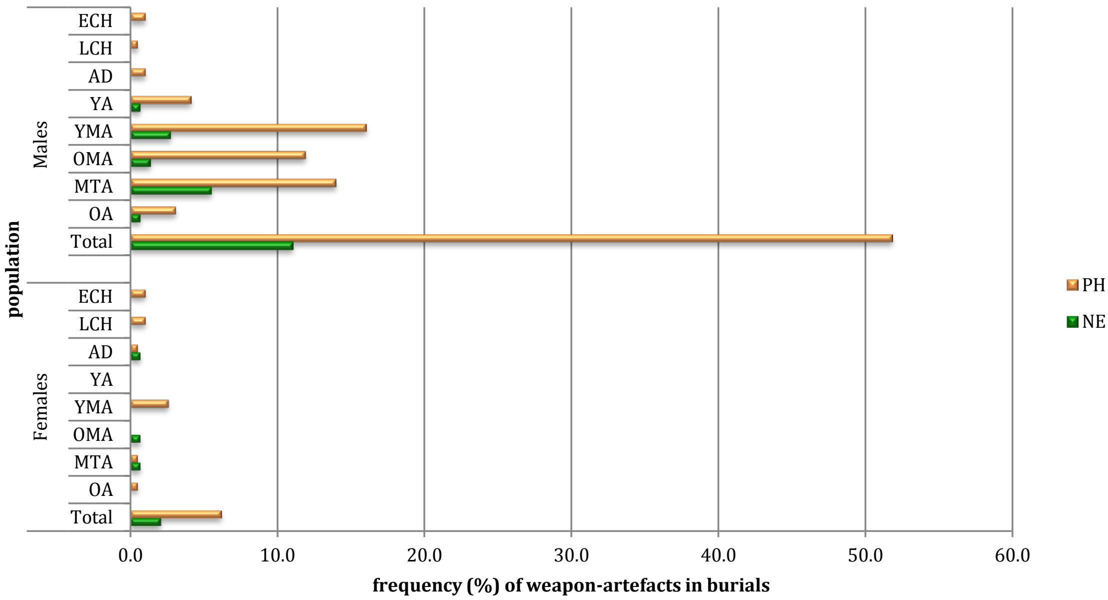


Fig. 5.54: Occurrence of weapon artefacts in burials - Comparison of sites

Weaponry in female burials

Table 5.22 and Table 5.23 display the details for adult female weapon burials in Pleidelsheim and Neresheim, including anthropological subcategories of sex assessment (marked as 'F?') and the ascription of 'archaeological sex' as preferably used in the cemetery catalogues (Knaut 1993 ; Koch 2001).

Table 5.22: Pleidelsheim - Female burials with items from the category '*weaponry*'

Skel n°	Sex		Age category	intact*	'weaponry' items	burial type	period
	anth.	arch.					
13	f	m	YMA	x	seax; arrows	A	IV
52	f?	m	YMA	-	seax; arrows	B	VIII
183	f	m**	OA	-	arrows	n. d.	n. d.
195b	f	f	MTA	-	arrows	C	V
223	f	m	A (OA?)	-	seax; arrows	C	VIII

*Graves that were not found intact are robbed, and in most cases also disturbed by that action.
**Burial contained remains of a male and a female (Koch 2001: 491).

Table 5.23: Neresheim - Female burials with items from the category '*weaponry*'

Skel n˚	Sex anth.	Sex arch.	Age category	intact*	'weaponry' items	burial type	period
7	f?	m	YMA	-	arrows	A	III-VI
21	f	m	OMA	-	shield**	A	VIII
88	f?	m	A	-	seax	B	VIII
135	f	m	MTA	-	seax; arrows	B	VII
61/2	f?	f	AD	-	seax	B	VIII

*Graves that were not found intact are robbed, and in most cases also disturbed by that action.
**This burial was robbed and disturbed with the skeletal remains of apparently three individuals found (two males, one female). However, the remains available for analysis and listed in the catalogue (Knaut 1993: 248) as the main burial were determined female by the author. Remains of a shield were found at the right foot end of the skeleton.

It is evident how the archaeologist's sex determinations concur seemingly agreeably with archaeologically gendered grave goods, even in cases where an already previous anthropological examination of the remains (Hahn 1993) cautioned that the individual looks 'rather female' ("*eher weiblich*", as in case of skeleton n˚ 7, Knaut 1993: 243) or determined the sex anthropologically as definitely female (as in case of skeleton n˚ 135, Knaut 1993: 300).

This wrongful attribution of gendered GG by archaeologists, especially of arrows and seax, has led to a number of cases of female children, but also of adolescent and adult individuals being 'determined' to be burials of males (App. 5, Tables 7 and 8, 13 and 14):

- in Pleidelsheim, 3 out of 13 female child burials are designated male; 7 out of 14 male child burials are designated female (due to beads and lack of 'weaponry' in the grave)
- in Neresheim, 1 out of 10 female child burials is designated male, 4 out of 10 male child burials are designated female, and 7 more remain archaeologically indeterminate, as no GG can be attributed.

The present evidence (cf. Chapter 5.2) substantiates the suggestion that arrows, and possibly also the seax, form burial regalia that are gender neutral, as well as, in the case of arrows, independent of age.

However, a seax may be used mainly as a functional, practical tool as well as a weapon and therefore can be listed as forming part of a 'full set' of weaponry, i.e. sword (*spatha*), seax, shield, lance and axe.

Weapon burials and the influence of age

The aspect of weapon types in relation to age-at-death of the individual they were buried with, and their significance for tracing age thresholds within a society has been discussed before (Chapter 5.2) and will therefore only be recapitulated here, with a more detailed focus on the nature of the individual weapon artefacts.

Since this section is more concerned with the weaponry evidence than the analysis of age, for reasons of clarity, the age categories are treated in four large groups consisting of:

- child (C, *c.* 1 - 15 years),
- young adult (YA, *c.* 16 - 25 years),
- middle adult (MA, *c.* 26 - 45 years),
- old adult (OA, 46+ years).

Table 5.24 and Table 5.25 delineate the distribution of weaponry artefacts by age category for the two populations.

Table 5.24: Pleidelsheim - Weaponry artefacts according to age (intact burials). Childhood is coded in blue, adolescence in orange, adulthood in violet.

Age category	Years	Sword	Seax	Bow	Arrow(s)	Shield	Lance	Spear	Helmet/ Armour	Axe	All weapon types
ECH	1 - 6	0	1	0	3	0	0	0	0	0	4
LCH	7 - 12	0	0	0	2	0	1	0	0	0	3
AD	13 - 17	0	1	0	1	0	0	0	0	1	3
YA	18 - 25	1	3	0	2	0	2	0	0	0	8
YMA	26 - 35	3	11	0	7	4	9	0	0	2	36
OMA	36 - 45	2	7	0	7	1	3	0	0	3	23
MTA	46 - 59	2	7	0	10	3	4	0	0	2	28
OA	60+	0	1	0	3	0	1	0	0	2	7
Total	All	8	31	0	35	8	20	0	0	10	112

Table 5.25: Neresheim - Weaponry artefacts according to age (intact burials). Childhood is coded in blue, adolescence in orange, adulthood in violet.

Age category	Years	Sword	Seax	Bow	Arrow(s)	Shield	Lance	Spear	Helmet/ Armour	Axe	All weapon types
ECH	1 - 6	0	0	0	2	0	0	0	0	0	2
LCH	7 - 12	0	0	0	2	0	0	0	0	0	2
AD	13 - 17	0	1	0	1	0	0	0	0	0	2
YA	18 - 25	0	1	0	1	0	0	0	0	0	2
YMA	26 - 35	1	1	0	1	1	1	0	0	0	5
OMA	36 - 45	2	0	0	0	1	0	0	0	0	3
MTA	46 - 59	3	2	0	1	1	3	0	0	0	10
OA	60+	0	1	0	0	0	0	0	0	0	1
Total	All	6	6	0	8	3	4	0	0	0	27

The concentration of weaponry assemblages during adulthood, i.e. of items that suggest admission to an age and gender group and potentially functionality[98], is immediately discernible for both populations (Fig. 5.55; Fig. 5.56), even with relatively small figures in Neresheim (Table 5.25).

Arrows (arrowheads) are found in male and female burials of all age groups in Pleidelsheim, primarily in those of YMA to MTA individuals (ca. 26 - 59 years), with

[98] Functionality can only be assessed by the analysis of blade wear and, potentially, weapon-related injuries on the skeleton.

highest prevalence in graves of MTA males. In Neresheim, their appearance as a GG is most frequent in childhood (Fig. 5.56) and stops with young adulthood in males but continues as a female grave object, which could imply and further strengthen the idea as a gender-neutral, generic and 'non-weaponry' item. It is during young middle adulthood that the data suggest a strong connotation of a man as fully adult and, moreover, in possession (if likened to life) or eligibility for a full set of weaponry.

The seax, compared to the heavier spatha, a lighter, single-edged sword, also occurs in Pleidelsheim as an artefact at all stages of life, with increased frequency in graves of YMA to MTA (Table 5.24). Although strongly associated with males in Pleidelsheim, its distribution, together with its 'neutral' character in Neresheim, suggests that this object may have been either of weapon character *or* of general utility.

Only swords (the double-edged *spatha*) and shields serve as true indicators of an age threshold: The latter is bestowed exclusively on males of young middle adulthood in both populations, while the sword appears in Pleidelsheim already in young adulthood, here together with the lance. Both in combination with the shield mark YMA burials (26+ years) in Neresheim.

All of these items, except for the lance in Pleidelsheim, cease to be GG for burials at old age (Fig. 5.55, Fig. 5.56). This indicates that a combination of those artefacts, possibly in different compositions, as case studies later in this study will demonstrate, is associated exclusively with adulthood, however, not with OA males.

Only seax and arrows seemed to have been assigned to male adults over the age of 60, as well as to children.

In Pleidelsheim, the axe (in rare cases, a *Francisca*, i.e. throwing axe) appears from adolescence onwards (Table 5.24; Fig. 5.55) and may add to the adult weaponry assemblage in this population, also being present up to the OA category.

The above observations point in addition to a functional, and not purely age-related, argument for the weaponry-types found in Pleidelsheim and especially Neresheim. If considered as used in life, lighter weaponry items, such as the seax, may well be found in graves of subadults as well as, if assuming heavier use, of women. More heavy objects such as the sword or lance are solely found in adult male burials, which could point to a certain level of practicability.

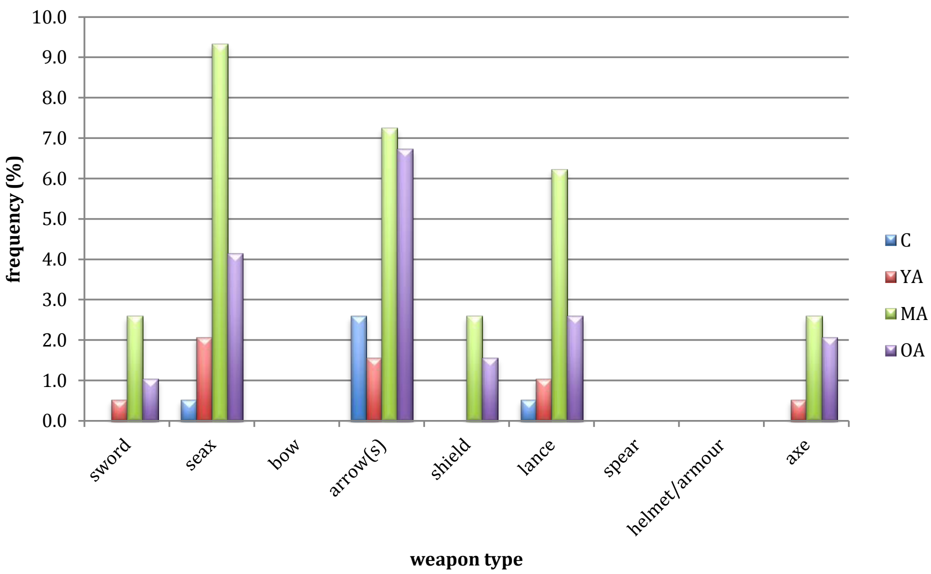


Fig. 5.55: Pleidelsheim - Distribution of weapon types in broad age categories

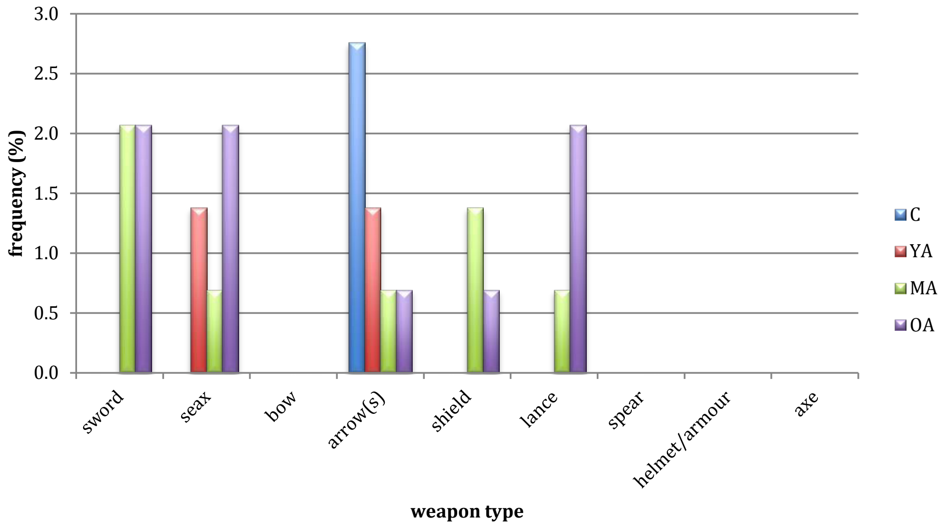


Fig. 5.56: Neresheim - Distribution of weapon types in broad age categories

5.3.2 Weapon Burials and Burial Wealth

In Pleidelsheim and Neresheim, all intact burials that contained weaponry also displayed other grave goods. Considering weaponry assemblages, male weapon burials in Pleidelsheim that included a sword consistently showed evidence of at least one other weaponry artefact within the grave. The question remains whether individuals buried with weapons were provided with a generally greater number and / or variability of GG. As male weapon burials are of the main interest, the average burial wealth of intact male graves with and without weaponry (but not without GG) in adolescence and adulthood was calculated and is shown in Table 5.26 (Pleidelsheim) and Table 5.27 (Neresheim).

Table 5.26: Pleidelsheim - Average burial wealth in intact male graves

	Male Adults				Male Adolescents			
	sample size	average n° of finds	average n° of artefact types	average n° of grave goods without weaponry	sample size	average n° of finds	average n° of artefact types	average n° of grave goods without weaponry
with weapons	35	9.2	6.9	3.8	2	4.0	3.5	2.5
without weapons (excl. unfurnished burials)	13	4.3	2.3	-	8	3.0	3.0	-

Despite the relatively small sample size, burial wealth seems to be linked to superior wealth both in terms of the number of GG and the number of AT in adult male weapon burials in Pleidelsheim, a difference when compared to adult burials without weaponry which is not as apparent in the burials of adolescent males (Table 5.26), yet it does exist in some.

When weaponry is taken out of the number of finds in a weapon burial, however, the average number of grave goods in such a burial is less than in those graves without weapon finds, indicating the significance of weaponry as grave goods.

Table 5.27: Neresheim - Average burial wealth in intact male graves

	Male Adults				Male Adolescents			
	sample size	average n° of finds	average n° of artefact types	average n° of grave goods without weaponry	sample size	average n° of finds	average n° of artefact types	average n° of grave goods without weaponry
with weapons	4	2.8	2.8	1.7	(1)	(2.0)	(2.0)	(1.0)
without weapons (excl. unfurnished burials)	7	3.4	2.7	-	(0)	(0)	(0)	-

In Neresheim (Table 5.27), the very small sample size when examining intact graves might obscure the picture. We find no apparent association between burial wealth and weaponry in graves of male adults when examining weapon burials and those with GG but no weaponry. Equivalently to Pleidelsheim, if weapons are subtracted from the number of grave goods in weapon burials, those burials tend to have less burial wealth on average than those without weaponry. The sample for intact graves of adolescent males in Neresheim only offered one individual and can therefore not being considered as conclusive for this aspect of analysis. It appears as if at Pleidelsheim, weapon burials were associated with an increase in burial wealth and variety, whereas in Neresheim, there does not appear to be such a tendency, but the results prove inconclusive at Neresheim due to small sample size.

A short note on artefacts and 'warrior characteristics'

It is often proposed in contexts from more or less confirmed 'warrior' burials that artefacts related to the activities of feasting or grooming are found in the graves of such individuals (Treherne 1995). Among the artefact types in the Alamannic burials under study, objects such as (drinking) vessels, glassware, and possibly pottery could be considered as relating to feasting, while scissors and tweezers, aside from their practical functionality, may be associated with grooming. Of these AT, only bronze vessels and tweezers could be potentially exclusively associated with male gender in the burials from Pleidelsheim and Neresheim, but most AT were found with both sexes and are described, in the case of scissors and tweezers, as forming part of the set worn on the belt by Alamannic individuals (Lohrke 2004a: 113).

In order to establish whether a combination of these AT relating to feasting or moveable personal equipment may constitute a difference between groups in the two cemeteries, their frequencies were analysed when they occurred in male burials both with and without weaponry, with the following outcomes:

a) Pleidelsheim

Frequencies of grave goods related to feasting…

… in burials with weaponry: 34.3 %

… in burials without weaponry: 15.4 %.

Frequencies of grave goods related to grooming…

… in burials with weaponry: 20 %

… in burials without weaponry: 7.7 %.

Interestingly, there are artefact groups in Pleidelsheim relating to feasting as well as grooming that differ between those burials with weaponry and those without, with a positive difference noted in weapon burials.

b) Neresheim

Frequencies of grave goods related to feasting…

… in burials with weaponry: 25 %

… in burials without weaponry: 0.0 %.

Frequencies of grave goods related to grooming…

… in burials with weaponry: 0.0 %

… in burials without weaponry: 14.28 %.

Also in this cemetery, items associated with feasting are found in weapon burials. In this case exclusively, however, items associated with grooming are only found in male burials without weaponry, providing a small but interesting piece of information regarding weapon burials in Neresheim.

5.3.3 Chronological variation - local differentiation?

As illustrated before (Chapter 5.2), there were intriguing differences between the populations of Pleidelsheim and Neresheim regarding their funerary customs of grave good deposition. At Pleidelsheim, '*weaponry*' follows the trend of almost all AT groups: the provision of graves with weaponry objects picks up during the 5th c. AD, sees a peak during the 6th c. and a decline with the 7th c. AD (Chapter 5.2.1, Fig. 5.42). At Neresheim, the presentation of weapon items in burials remains constant during the 5th and 6th centuries and rises during the 7th c. AD (Chapter 5.2.1, Fig. 5.47).

A closer look at individual weaponry artefacts reveals that in Pleidelsheim (Fig. 5.57), the decline in weapons as GG in male burials was not limited to a single item or group of weaponry but extended to all types of weaponry in similar ways. Swords see the steepest decline with the 7th century, while the axe does not occur as an artefact at all by this time.

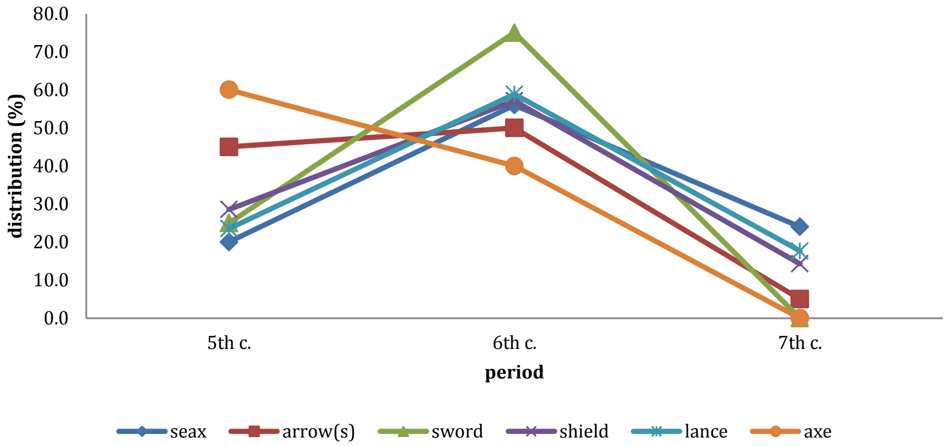


Fig. 5.57: Pleidelsheim - Distribution of weapon artefacts over time

This pattern might signify a general distancing from weaponry as burial accoutrements during the course of the 7^{th} c. AD, or indicate a change in 'military equipment' should the provided artefacts mirror their presence and possible use during the course of a man's life.

Unfortunately, in Neresheim, the sample size is very reduced as only few of the intact burials could be dated and placed into the periods of use of these early medieval cemeteries (for instance, only weapon graves starting with the end of the 5^{th} c., as opposed to phases I and II (see Chapter 4.1.3), could be included in this analysis). However, there is still enough material to discern a trend in the cemetery sample of weapon burials that follows the pattern for AT distribution outlined before, with regard to the individual weaponry AT (Fig. 5.58):

While the seax could only be found in burials from the 6^{th} c. onwards and axes not at all, swords, lance and also arrows as burial goods show a constant increase from the 6^{th} to the 7^{th} c. AD. This change in deposition might be described as a reverse trend to what could be observed in Pleidelsheim, an indication of local differentiation in the provision of weapons in burials.

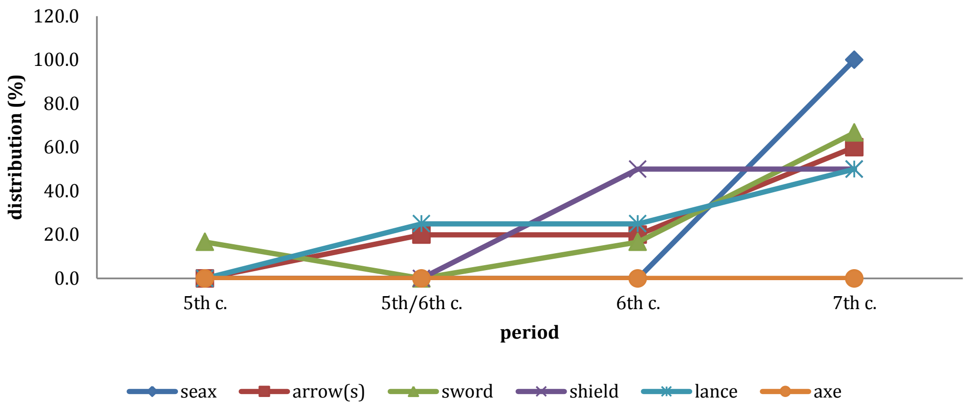


Fig. 5.58: Neresheim - Distribution of weapon artefacts over time

It has been proposed that the frequencies of different items of weaponry and changes in their distribution over time could have to do with ‘models of culture’ ('*Kulturmodelle*', Siegmund 1997 ; Brather 2002), i.e. an approximation in identity towards either the ‘Frankish’ or the ‘Alamannic’ *gentes.* During the 6th and 7th centuries, in ‘Frankish’ cemeteries there would be an apparent predominance of spearheads and axes, and in ‘Alamannic’ cemeteries a preponderance of swords and the seax (Brather 2002). Although spearheads are lacking from the two cemeteries under study, there is evidence of lances in both, and a comparison of frequencies in distribution of individual weaponry items between Pleidelsheim and Neresheim may be revealing differential patterns.

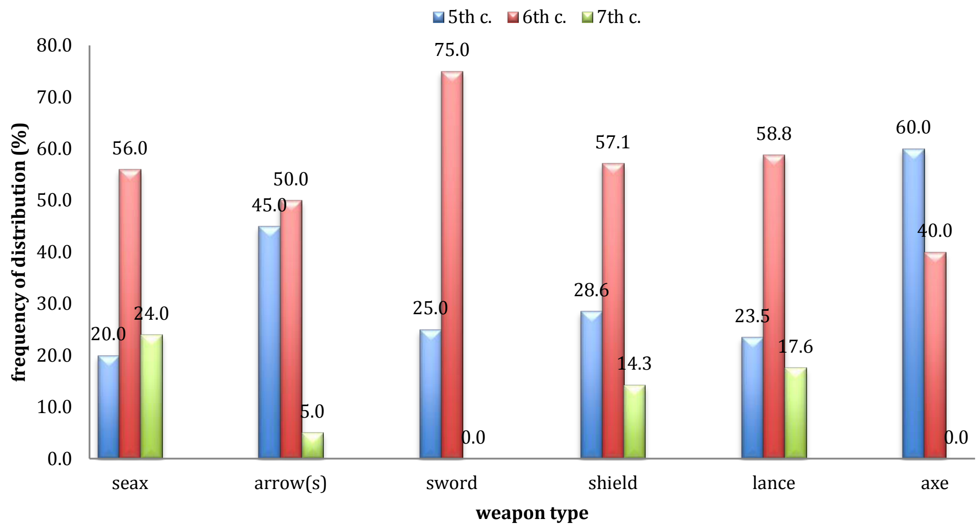


Fig. 5.59: Pleidelsheim - Frequency of weapon artefacts across periods

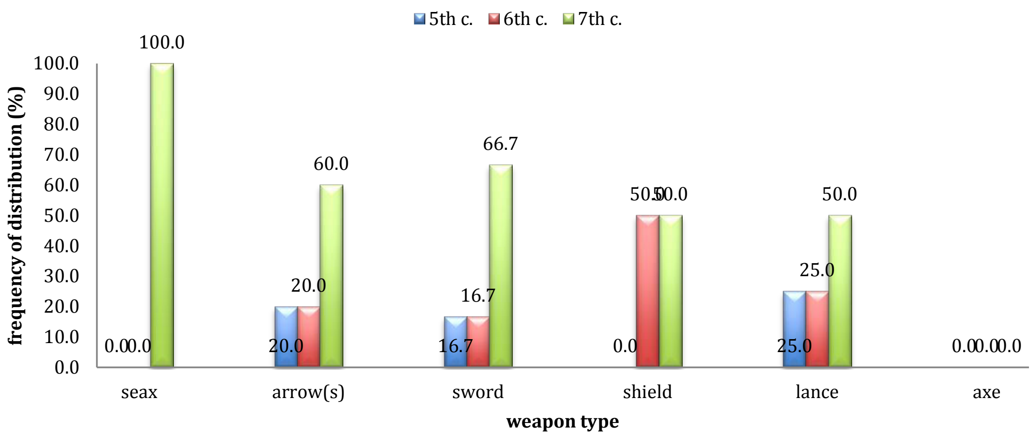


Fig. 5.60: Neresheim - Frequency of weapon artefacts across periods

Fig. 5.59 and Fig. 5.60 show the frequency of weapon types in Pleidelsheim and Neresheim across the centuries. At a glance, it is apparent that those two cemeteries do not comply with the proposed models. The differential distribution of weaponry artefacts confirms the observations made before. During the 6th c. AD, burials at Pleidelsheim possess more lances and axes within their assemblages than those in Neresheim. The type ‘axe’ is not present at all in Neresheim at that time.

There are significantly more swords as well as seaxes in the Pleidelsheim assemblage than in that from Neresheim ($p = .000^{**}$), the latter weapon type not appearing in Neresheim until the 7th c. AD.

In the course of the 7th c., burials at Neresheim show considerably more lances than those in Pleidelsheim, while the axe now also disappears in Pleidelsheim. The same applies to the sword, which at the same time sees a steep increase at Neresheim.

This means, overall, weaponry assemblages in Pleidelsheim move from the inclusion of many swords and axes to no swords and axes, from many arrows to only few, and a similar decline at equal rates for lance and shield. There is a strong preponderance of lance and axe in the 6th c. AD, but also of swords and seax at the same time. Neresheim shifts, given the evidence from intact burials, from no seax and only few swords as well as arrows to supposedly more frequent presence of the items in the GG assemblages.

In conclusion, the archaeological evidence of the weapon burials in Pleidelsheim and Neresheim, in conjunction with the biological factors of age and sex, points to a differential expression of the burial rite between the two cemeteries as well as within the early medieval setting.

The archaeological components of the weapon burials suggest the existence of distinctive life course structures, not only with regards to males but also to females that provide indications of functional and symbolic meanings of weaponry. These tendencies highlight the expression of social as well as age- and gender-related status via burial wealth, and implicate the possibility of variability in weapon sets within the burial samples depending on time- as well as age-related factors, all of which counterpoise a simple division into 'warrior' or 'peasant', 'young' or 'old', 'wealthy' or without weaponry, as well as the notion of 'the Alamanni' as a warrior society.

In these cemeteries, the analysis of physical characteristics as well as a look at individual cases of weapon burials will further define and, given the scattered character of material evidence especially in Neresheim, reveal further clues to the interpretations of weapon burials, their explanatory power towards social complexity, and, eventually, the Alamannic 'warrior'.

5.4 Conclusion: A life in categories? Age, sex and gendered identities

As this chapter has demonstrated, with the significant outcomes summarized below, we are presented with a very differentiated picture of two populations that are encapsulated in the term 'the Alamanni'. The analysis of the burial rite so far has revealed important indications regarding the differential treatment of males and females and investment in their burial with regards to burial style, quantities and variety of grave goods, as well as to the possible meanings of artefacts found deposited in the graves, and suggests compelling differences between the people from Pleidelsheim and Neresheim. The weapon burial rite is elucidated with regard to its shifting meaning towards the life course and the idea of the Alamannic 'warrior'.

Moreover, this analysis revealed aspects of social status, age and gender identity, highlighting thresholds that defined the life course and fluidity between these identities as well as of the social importance for the different groups within the two societies that hitherto were concealed by general presumptions about the Alamanni. Yet the results so far are subject to the constraints not only imposed by the nature of burial data, the intentionality of artefactual evidence found in burials, but also by a relatively high occurrence of grave robbery in Pleidelsheim and Neresheim, intermittently rendering the interpretation difficult. The correlation between these results with information obtained from the physical and palaeopathological analysis of the only 'non-intentional' evidence we have from these cemeteries, the skeletal remains, will lead to a more nuanced and refined understanding of the physical as well as social conditions under which these individuals lived and died.

I. Pleidelsheim (PH)

General Characteristics

Demography:
- similar mortality profile for M and F, with peak of age-at-death at YMA - MTA (ca. 35-59 years); more F than M survive into OA (60+ years)
- childhood mortality: more girls pass away in ECH (1-6 years), more boys at LCH (7 -12 years); more children in PH pass away in ECH than in NE, less children in PH in LCH

Burial types:
- 5th c.: coffins and simple graves, with preponderance of coffin burials
- 6th c.: appearance of chamber graves & strong increase; more coffin burials than simple interments
- 7th c.: less chamber graves & coffin burials, slightly more simple burials

GG deposition customs:
- overall 11+ AT for M and F
- increase of artefact deposition custom with 6th c., overall decline with 7th c.

Burial Ritual & Social Identity: Males

General:
- predominantly coffin burials = most GG & AT
- chamber burials: ECH, YA - MTA
- more AT quantities in childhood than F
- all AT except for '*costume & jewellery*' objects follow general deposition decrease with 7th c.

ECH:
- up to 4 AT
- 'neutral' AT

LCH:
- up to 7 AT
- 'neutral' AT

AD:
- up to 7 AT
- 'neutral' GG

YA:
- up to 10 AT
- appearance of gendered & elaborate AT

YMA:
- 11+ AT;
- full complement of gendered AT

OMA:
- 11+ AT
- gendered & elaborate AT present

MTA:
- 11+ AT; highest quantity & variety of AT
- gendered & elaborate AT present

OA:
- up to 10 AT
- gendered & elaborate AT present

Burial Ritual & Social Identity: Females

General:
- chamber burials: more frequently than M; LCH, YA - OA
- more AT variety in childhood than M
- from YMA - MTA, more symbolism in artefactual nature from YMA - MTA
- with 7th c., change in artefactual gender distinction suggested ('*grave furnishings*')

ECH:
- up to 7 AT; higher quantity of GG than in LCH
- 'neutral' AT

LCH:
- up to 7 AT, significantly more than M
- appearance of 1 gendered AT

AD:
- up to 4 AT
- 'neutral' AT

YA:
- 11+ AT
- appearance of gendered & elaborate AT

YMA:
- 11+ AT
- full complement of gendered AT

OMA:
- 11+ AT; highest quantity & variety of AT
- gendered & elaborate AT present

MTA:
- 11+ AT
- gendered & elaborate AT present

OA:
- 11+ AT
- gendered & elaborate AT present

Weapon Burials

- up to 5 weaponry types included in 1 weapon burial
- significantly more seax in PH than in NE, as well as more of all other weapon types
- if weapon burial, always at least 1 other weaponry item included
- 6th c.: sword, seax, axes, arrows, shield, lance 7th c.: no swords, axes, fewer arrows, shield, lance
- average AT wealth in weapon graves greater than in other burials
- symbolic as well as functional argument
- items associated with feasting & grooming potentially strongly associated with weapon burials

II. Neresheim (NE)

General Characteristics

Demography:

- generally similar mortality profile for M and F, with peak of age-at-death at YMA - MTA (ca. 35-59 years); significantly higher mortality of YA F (ca. 18-25 years); more M than F survive into OA (60+ years)
- childhood mortality: more boys pass away in ECH (1-6 years) and LCH (7 -12 years); more children in NE pass away in LCH than in PH, less children in NE in ECH

Burial types:

- 5th c.: coffins and simple graves, with preponderance of coffin burials
- 5th - 6th c.: appearance of chamber graves; slightly more coffin burials than simple interment
- 7th c.: chamber burials remain constant; surge of simple interments, increase in coffin burials

GG deposition customs:

- max. 8 - 10 AT; overall less quantity & variety in NE than in PH
- more grave robbery than in PH
- more artefactual wealth in child burials (M)
- relatively low amounts of artefact deposition in 5th and 6th c., overall increase with 7th c.

Burial Ritual & Social Identity: Males

General:

- chamber burials: ECH, LCH, OMA, MTA
- in adulthood, higher artefactual wealth but not variety than F

ECH:

- up to 10 AT (maximum)
- 'neutral' AT

LCH:

- up to 4 AT
- 'neutral' AT

AD:

- up to 4 AT
- 'neutral' AT

YA:

- 'neutral' AT (?)

YMA:

- (up to 4 AT)
- full complement of gendered AT

OMA:

- up to 7 AT; highest quantity & variety of AT
- gendered & elaborate AT present

MTA:

- up to 7 AT;
- gendered & elaborate AT present

OA:

- up to 4 AT
- 'neutral' AT, still elaborate AT

Burial Ritual & Social Identity: Females

General:

- chamber burials: LCH, YA, OMA, MTA; GG in chamber graves at young age, not in OMA (MTA?)
- overall less GG than M, and much less than in PH F

ECH:

- 1 AT
- 'neutral' AT

LCH:

- up to 7 AT
- 'neutral' AT

AD:

- very low AT numbers
- appearance of 1 gendered AT

YA:

- up to 10 AT (maximum)
- full complement of gendered AT, & elaborate

YMA:

- up to 7 AT; highest quantity & variety of AT
- gendered & elaborate AT

OMA:

- up to 7 AT; highest quantity & variety of AT
- gendered & elaborate AT

MTA:

- up to 7 AT
- gendered AT

OA:

- 1 AT
- 'neutral' AT

Weapon Burials

- less weaponry deposited in burials than in PH, only up to 2 weapon types
- no axes; 6th c.: sword, arrows, shield, lance; 7th c.: increase of sword & arrows, lance, appearance of seax
- no evidence for weapon burials of having been wealthier than other burials
- arrows cease with burials of YA M
- items associated with feasting predominantly recurring in weapon burials

6 Biology and Funerary Context

A comparative examination of physical (i.e. biological indicators provided by skeletal data) and archaeological variables (i.e. material evidence provided by the funerary context) can reveal details of their reciprocal relationships in the formation of social status and their possible implications for the living conditions of the populations under study. In a society with potentially high social mobility, as suggested by both historical and archaeological data (cf. Chapter 3.1), both the possibility that certain biological characteristics (e.g. stature, a measure of well-being) may condition social status, or, much more commonly, that social status affects health status, must be considered. Therefore, this chapter explores these relationships between health and well-being and social status in the populations from Pleidelsheim and Neresheim.

Aside from examining stature, the general palaeopathological profile of the populations under study encompasses a focus on the following variables which may indicate discrepancies between males and females, different age groups, and individuals of differing social status: childhood stress indicators (cribra orbitalia, dental enamel hypoplasia), non-specific infections (tibial periostitis, maxillary sinusitis), vertebral and extra-vertebral degenerative joint disease, dental pathology, and trauma. This consideration is followed by an examination of potential relationships between these skeletal conditions and grave good provision as well as burial context, regarding individuals buried with and without grave goods, with grave goods but without weaponry, and, finally, those interred in 'weapon burials'. This analysis permits the comparison of groups displaying differential funerary treatment and the tracing and identification of distinguishable subgroups among the people of Pleidelsheim and Neresheim.

The statistical methods in this chapter mainly consist of cross-tabulations of biological and archaeological variables in order to assess possible relationships between them. They include, in addition to descriptive statistics, independent sample t-tests for continuous numerical data, ANOVA, χ^2-tests or Fisher's Exact test (for sample sizes < 5) for nominal data, considering differences within and among the samples, non-parametric tests (Mann-Whitney U test or Kruskal Wallis' H test) for ordinal and interval data, as well as Spearman's Rank Correlation Coefficient test for analyzing possible relationships between variables. The null hypothesis posits that no significant relationship exists between the skeletal and archaeological variables, with the threshold α set at .05 (*, significant) and .01 (**, highly significant) levels.

Grave good data from intact burials of individuals of determined age and sex were employed for a comparison between physical and artefactual data, while weapon artefact data were collated from all burials of individuals of determined age and sex.

6.1 Pleidelsheim and Neresheim: The Skeletal Evidence

Subadult morbidity

Considering the generally very degraded nature of subadult skeletal remains in the samples of Pleidelsheim and Neresheim, often leaving only fragments and the dentition for analysis, only a relatively small number of subadults could be observed for pathological changes, with even smaller subsamples when divided into age and sex. A detailed list of pathological changes of subadult skeletal remains can be found in the 'Catalogue of Children's Burials' (App. 4, Tables 3 and 4), with a summary of skeletal evidence of disease in subadult remains displayed in Table 6.1 and Table 6.2.

In Pleidelsheim, the skeletal remains of 15 male (ECH: 7, LCH: 7) and 13 female (ECH: 9, LCH: 4) children could be analysed (Table 6.1: Pleidelsheim - Pathological changes of subadult remains). Indicators of non-specific infections were observed only in females (38.5 %), while one case of possible active scurvy in late childhood was found among the male sample (Skel. PH 6).

Stress indicators, i.e. cribra orbitalia and dental enamel hypoplasia, occurred frequently in both sexes throughout childhood. Females seem to show a tendency for a higher prevalence of cribra orbitalia during early childhood (66.7%, vs. 28.6% in male children), however this was not found to be statistically significant (Fisher's exact test). One case of peri-apical disease, an abscess, was found in the deciduous dentitions, however, no other indications of dental disease in this sample.

Table 6.1: Pleidelsheim - Pathological changes of subadult remains

Sex	Age category	metabolic disease (scurvy)	non-specific infection	cribra orbitalia	dental enamel hypoplasia	other pathological changes
Males	**ECH**	-	-	2[a)]	-	-
	LCH	(1)	-	2	2	-
Females	**ECH**	-	3	6[a)]	-	1[b)]
	LCH	-	2	2	1	-

[a)] one case of severe C.O.; [b)]peri-apical disease (dental abscess)

In Neresheim, the skeletal remains of 20 children (10 males, ECH: 5, LCH: 5; 10 females, ECH: 4, LCH: 6) could be observed for pathological changes (Table 6.2).

Table 6.2: Neresheim - Pathological changes of subadult remains

Sex	Age category	metabolic disease (scurvy)	non-specific infection	cribra orbitalia	dental enamel hypoplasia	other pathological changes
Males	**ECH**	-	-	3[b)]	1	-
	LCH	1	1	3[c)]	2	1[d)]
Females	**ECH**	2[a)]	-	1	-	-
	LCH	-	-	2	2	-

[a)]one case = possible scurvy; [b)]two cases of severe C.O.; [c)]one case of severe C.O.; [d)]neoplasm

Also in this sample, pathological changes related to childhood stress occur equally throughout childhood in male and female children, with no significant difference to the children of Pleidelsheim. No cases of dental disease were detected, and only one case of non-specific infection; however, the poor preservation of postcranial skeletal material in most cases did not permit any observations regarding infectious changes in the subadult skeleton.

Nonetheless, three cases of scurvy, one of them a possible case, were detected, more than in Pleidelsheim, yet not significantly so. One of them, the skeleton of a girl who died at 3 - 4 years (± 12 months) of age (Skel. 33) and was buried in a coffin without any grave goods, displays signs of extensive and active new bone formation, lesions distributed unevenly across the endocranial surface (including parietals, occipital, frontal and temporals, as well as sphenoid) as well as the ectocranial table (zygomatics, maxilla, temporals; Fig. 6.1). The orbital roofs show severe cribra orbitalia, the orbital plates patches of porous bone formation. On the long bones, especially the humeri and femora, new bone formation appears near the metaphyses.

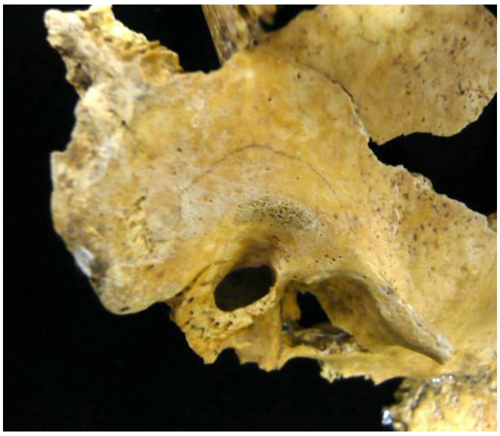


Fig. 6.1: Skel. NE 33. Example for new bone formation above the right external auditory meatus.

Especially interesting is the occurrence of dental modification due to continuous suckling on a relatively hard implement, probably a spoon or similar (Fig. 6.2). A child with a severe case of scurvy would have constantly given the impression of being hungry and therefore would have most likely be assuaged with something to suck on (*pers. comm.* K. Manchester 2010).

Fig. 6.2: Skel. NE 33, dental modification. The occlusal surfaces of 51 and especially 52, as well as of 61 and 62 show a curved abrasion pattern congruent with the frequent presence of a nursing object between the child's teeth.

In the skeletal remains of the boy from burial 176 in Neresheim, who died in late childhood, at the brink of adolescence (ca. 12 years ± 30 months) and was buried in a coffin without any grave goods, we are presented with a very rare case of a malignant tumour in the vertebral column, located at the neural arch of T8, which displays very disorganised bone and focal destruction on its dorsal aspect, as well as a bony exostosis towards the vertebral canal and spinal cord, which would have been very probably fatal (*pers. comm.* K. Manchester, D. Ortner, 2010, for confirmation of diagnosis).

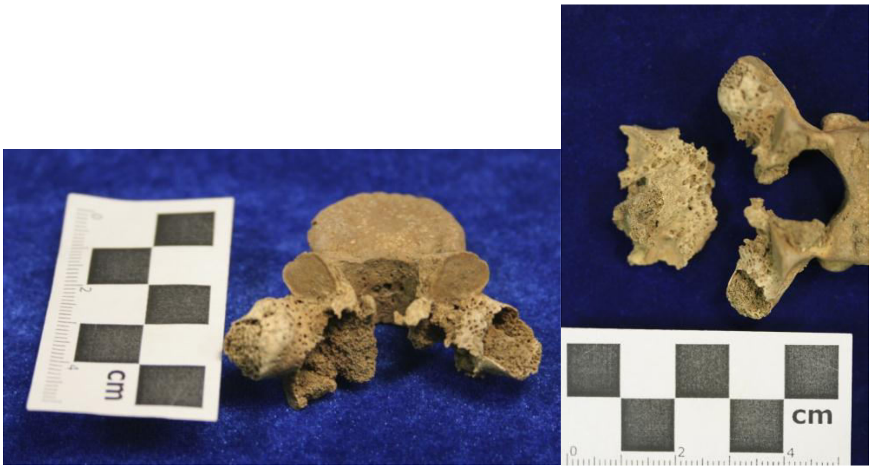


Fig. 6.3: Skel. NE 176. Destruction of Vt 8 by spinal tumour.

Adult skeletal evidence

Suitable condition and preservation of the skeletal material permitting, cranial and postcranial measurements were taken in order to calculate stature and aid the determination of sex of individuals. Only those measurement results relating to stature estimation are presented forthwith, as adult stature can be related to a number of factors (i.e. social, economic and health circumstances) within the bio-cultural environment (Larsen 1997 ; Schweich 2005).

6.1.1 Stature

Average stature estimates were calculated for adult individuals who presented at least one intact long bone, using stature estimation formulae proposed by Pearson (1899), Breitinger (1937) for males and Bach (1965) for females, as well as by Trotter (1970). The results are listed in Tables 1 and 2 (Pleidelsheim) and Tables 3 and 4 (Neresheim) in App. 6 for those individuals whose sex could be determined.

A combination of femur and tibia measurements provides the most reliable results for body height estimates, and these elements were used where possible. If only one was available, the length of the tibia was used. In case of long bones from both sides being present, the longer measurement was used for stature estimation. Stature calculation formulae as proposed by Trotter and Gleser (1952 ; Trotter 1970), with corrections from Trotter and Gleser (1977) are widely used for prehistoric populations and did not show statistically significant deviations from the other stature estimates, albeit generally resulting in 2 - 5 cm taller stature estimates on average. They will be used for the purpose of further analysis, as the Trotter formulae produce comparable results for body height estimates with regards to other early medieval cemetery populations across Europe and involve considerably less distortion of male : female stature estimates than the formulae proposed by Breitinger (1937) and Bach (1965) (Siegmund 2010: 25). From Pleidelsheim, body height of 52 males and 60 females could be estimated, while from Neresheim, the stature of 27 males and 42 females could be ascertained (App. 6, Tables 1 - 4).

Table 6.3: Body height means by site and sex (using Trotter 1970)

Site	**Males**			**Females**		
	n°	**mean***	**S.D.**	**n°**	**mean***	**S.D.**
Pleidelsheim	52	174.2	6.2	60	162.0	7.2
Neresheim	27	177.2	7.4	42	164.1	6.3

*average body height in cm

As the results in Table 6.3 demonstrate, the mean stature for males from Pleidelsheim was estimated to 174.2 cm (range 159.1 - 184.7 cm; App. 6, Table 1). Female mean stature was 162.0 cm (range 146.6 - 180.4 cm; App. 6, Table 2). In both sexes, stature estimates follow a normal distribution (Fig. 6.4), with sexual dimorphism in stature of 10.6 cm.

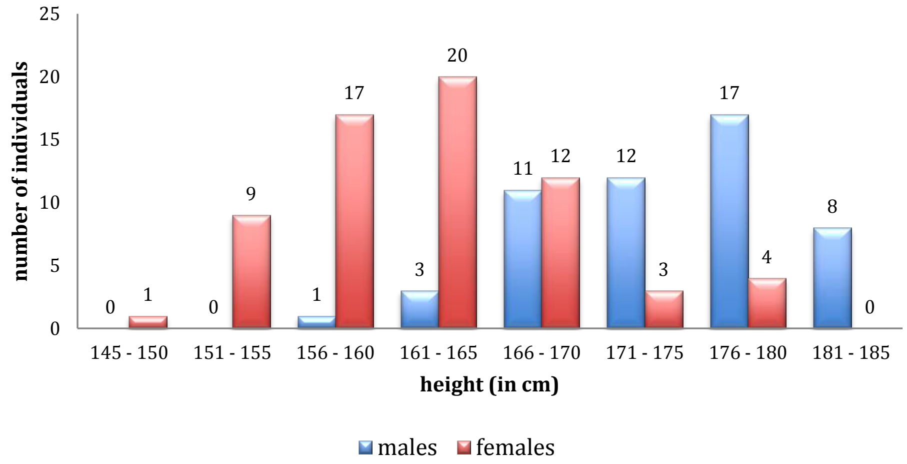


Fig. 6.4: Pleidelsheim - Comparison of male and female stature estimates

In Neresheim, males reached an average height of 177.2 cm (Table 6.3; range 165.6 - 203.6 cm; App. 6, Table 3), females 164.1 cm (Table 6.3; range 151.3 - 178.4 cm; App. 6, Table 4). Also here, both height estimate distributions follow a normal distribution (Fig. 6.5), with sexual dimorphism in stature of 10.8 cm.

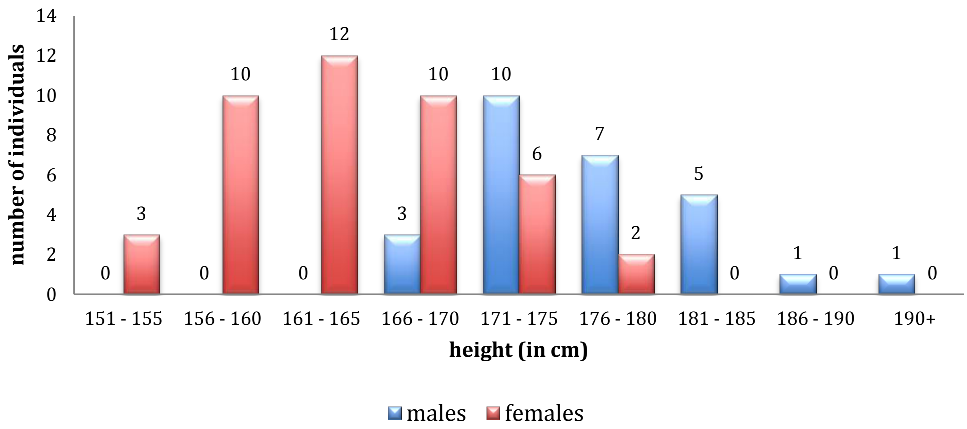


Fig. 6.5: Neresheim - Comparison of male and female stature estimates

A comparison with stature estimates from other early medieval cemetery sites in the area of southwest Germany (Table 6.4) shows that the estimated stature for males and females from Pleidelsheim and Neresheim fall within the range of stature estimates from contemporary sites.

Table 6.4: Comparable stature estimates from early medieval cemeteries in the area of southwest Germany

Site	Males		Females	
	mean*	S.D.	mean*	S.D.
Hemmingen (5th/6th c. AD)[1)]	176.0	3.2	163.5	3.6
Wyhl (5th/6th c. AD)[1)]	177.8	2.9	164.0	0.0
Horb-Altheim (5th/6th c. AD)[1)]	174.0	3.2	163.3	3.3
early medieval period (5th - 7th c. AD)[2)]	170.5	2.1	158.6	3.1

*average body height in cm; [1)]from Obertová 2008: 152, using Bach / Breitinger (1937 / 1965); [2)]from Siegmund 2010: 84f., combined stature estimates from cemeteries in south-west Germany, using Trotter & Gleser (1952)

A comparison of body height estimates revealed no statistically significant difference between the stature of males from Pleidelsheim and from Neresheim (independent samples t-test, p = .058), although there seems to be a trend for males from Neresheim to be taller on average than those from Pleidelsheim (Fig. 6.6).

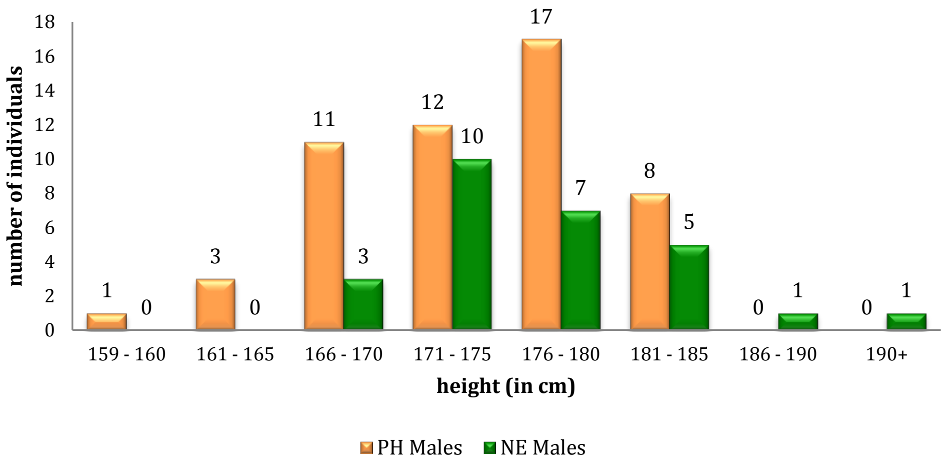


Fig. 6.6: Comparison of stature estimates Pleidelsheim and Neresheim - Males

The same can be observed in a comparison of the female samples (Fig. 6.7; independent samples t-test, p = .124), albeit without a tendency present.

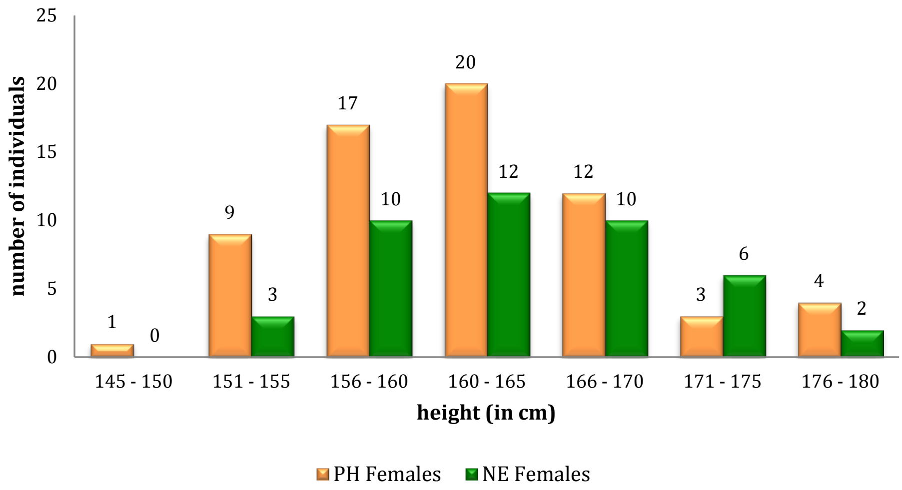


Fig. 6.7: Comparison of stature estimates Pleidelsheim and Neresheim - Females

The degree of sexual dimorphism between the two populations does not differ and is within the range of the average for early medieval cemeteries in southwest Germany (11.8 cm ± 2.3, Siegmund 2010: 86f.).

Stature and burial types

When examining the body height estimates for different burial types, no statistically significant difference was found in Pleidelsheim (Table 6.5) regarding the stature of males buried in either coffins (grave type A), 'simple' graves (type B) or chamber burials (grave type C) ($F = 1.368$, $p = .267$; one-way ANOVA with Bonferroni correction). Yet, there is a tendency for individuals buried in chamber graves to be taller on average than those in more 'simple' burial styles, a relationship that occurs as such in every group under study, even if not statistically definable (Cowgill 1977), as can be seen below.

Table 6.5: Pleidelsheim - Comparison of body height in different burial types - Males

	grave type A[1)]	grave type B[2)]	grave type C[3)]
max	183.7	181.0	184.7
min	159.1	160.9	170.6
mean*	174.5	171.8	177.2
S.D.	6.5	7.0	5.1

[1)]coffin burial; [2)]'simple' burial; [3)]chamber burial; *all means from stature estimates using Trotter (1970)

Table 6.6: Pleidelsheim - Comparison of body height in different burial types - Females

	grave type A[1)]	grave type B[2)]	grave type C[3)]
max	180.4	169.4	172.9
min	151.2	151.2	156.6
mean*	161.6	160.1	164.0
S.D.	8.0	5.3	4.5

[1)]coffin burial; [2)]'simple' burial; [3)]chamber burial; *all means from stature estimates using Trotter (1970)

Regarding females in Pleidelsheim (Table 6.6), likewise, no statistically significant difference in body height could be traced among the three different grave types ($F = 1.270$, $p = .291$; one-way ANOVA, with Bonferroni correction).

This is in agreement with previous findings from early medieval cemeteries of the same region (e.g. Basel-Bernerring, Siegmund 2010: 97) where no statistically significant difference in the height of males or females was found when comparing individuals buried in chamber graves and coffins.

An analysis of male burials in different styles in Neresheim (Table 6.7) shows a divergent picture: Here, a comparison between males buried in coffins (grave type A) and 'simple' graves (grave type B) resulted in a statistically significant difference between the two groups ($t = 2.987$, $p = .007$**), with males buried in coffins being taller on average than those buried in the most simple style.

Table 6.7: Neresheim - Comparison of body height in different burial types - Males

	grave type A[1)]	grave type B[2)]	grave type C[3)]
max	203.6	178.2	181.3
min	168.6	165.6	178.9
mean*	179.9	172.6	180.1
S.D.	8.2	3.8	1.7

[1)]coffin burial; [2)]'simple' burial; [3)]chamber burial; *all means from stature estimates using Trotter (1970)

Since stature estimates could only be obtained for two males buried in chamber graves, a comparison of all three types of burials was not possible; however, the average stature of males in chamber graves is almost identical to that of males interred in coffins, i.e. significantly taller than those receiving a simple burial in Neresheim.

This finding draws an interesting parallel to grave good distribution and burial types (Chapter 5.2.1), i.e. the fact that males buried in most simple graves also displayed the highest frequency of complete artefact absence. Adding to this the factor of comparatively smaller stature in these burials, some incipient social distinction, expressed by the choice of burial mode, might be suggested.

Also among the different burial types in the female sample from Neresheim (Table 6.8), the low number of chamber grave interments with calculable body height made a statistical comparison between all three burial types impossible. However, the stature estimates between females buried in coffins and those buried in 'simple' graves did not differ significantly (p = .162). Interestingly, on average, females buried in the most simple manner (grave type B) seem to have been slightly taller than those buried in coffins.

Table 6.8: Neresheim - Comparison of body height in different burial types - Females

	grave type A[1)]	grave type B[2)]	grave type C[3)]
max	174.1	178.4	175.4
min	155.4	151.3	158.7
mean*	162.5	165.2	167.0
S.D.	5.4	6.5	11.8

[1)]coffin burial; [2)]'simple' burial; [3)]chamber burial; *all means from stature estimates using Trotter (1970)

6.1.2 Palaeopathological analysis: Indicators of skeletal health and stress

6.1.2.1 Indicators of childhood stress: Cribra orbitalia and dental enamel hypoplasia

a) Pleidelsheim

Cribra orbitalia

In total, 100 crania with at least one intact orbital roof could be observed for the presence (Table 6.9) as well as severity of cribra orbitalia (hereafter: CO), 47 of which were from male individuals, 53 from females. Thirty-six individuals (42.6 % males and 30.2 % females) displayed the condition, with all observed lesions being healed and ranging from slight to moderate CO. No significant difference was detected in the prevalence of CO between the two sexes, albeit males show a slight tendency for a higher prevalence of the condition, the contrary of what could be observed in the children's sample (Table 6.1) - in childhood, females seemed more disposed to CO than males.

Table 6.9: Pleidelsheim - Prevalence of cribra orbitalia and dental enamel hypoplasia

	Prevalence by sex					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
Cribra orbitalia	20/47	42.6	16/53	30.2	36/100	36.0
Dental enamel hypoplasia	17/45	37.8	27/56	48.2	44/101	43.6
Co-occurrence of CO and DEH	7/30	23.3	5/42	11.9	12/72	16.7

A = affected, O = observed


Fig. 6.8: Cribra orbitalia of the right and left orbit, Skel. PH 167

Dental enamel hypoplasia

Dental enamel hypoplasia (hereafter: DEH) was found in 44 individuals (43.6 % of the observable population), with females showing slightly more cases (48.2 %) on average than males (37.8 %; Table 6.9). However, there is no significant difference in the occurrence of DEH between males and females.

Co-occurrence of cribra orbitalia and dental enamel hypoplasia

Co-occurrence of these two conditions relating to childhood stress (Table 6.9) was only found in few cases (16.7 %). Males show a tendency for a higher prevalence of childhood stress indicators (23.3 %, vs. 11.9 % in females); this was not found to be significant, however.

b) Neresheim

Cribra orbitalia

In Neresheim, 80 crania (26 of males, 54 of females) with at least one observable orbital roof could be examined for the presence and severity of CO (Table 6.10). More than half of the population (53.8 %) showed signs of this condition, with males being slightly more affected than females, something that is already reflected in childhood when male individuals displayed an increased, albeit not significantly higher, prevalence rate of CO (60 % in males vs. 30 % in females).

Table 6.10: Neresheim - Prevalence of cribra orbitalia and dental enamel hypoplasia

	Prevalence by sex					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
Cribra orbitalia	16/26	61.5	27/54	50.0	43/80	53.8
Dental enamel hypoplasia	19/26	73.1	34/49	69.4	53/75	70.7
Co-occurrence of CO and DEH	9/26	34.6	10/49	20.4	19/75	25.3

A = affected, O = observed

Dental enamel hypoplasia

DEH was found to be present in 70.7 % of observable adult individuals in Neresheim (Table 6.10), in almost equal parts in males (73.1 %) and females (69.4 %).

Co-occurrence of cribra orbitalia and dental enamel hypoplasia

A combined occurrence of CO and DEH, suggesting increased levels of childhood stress, occurs in 25.3 % of observable cases in Neresheim (Table 6.10), with a tendency in males for a higher, yet not significant, prevalence of combined conditions than found in females (34.6 % vs. 20.4 %).

c) Inter-population comparisons

While no significant differences between males and females regarding childhood stress indicators could be discerned in Pleidelsheim or Neresheim, a comparison of both populations reveals noteworthy disparities.

Table 6.11: Occurrence of cribra orbitalia in Pleidelsheim and Neresheim

CO	M PH * NE	F PH * NE	all PH * NE
%	42.6 * 61.5	30.2 * 50.0	36.0 * 53.8
χ2	2.414	4.367	5.686
p	.120	.037*	.017*

*significance at p<.05 level; **significance at p<.01 level

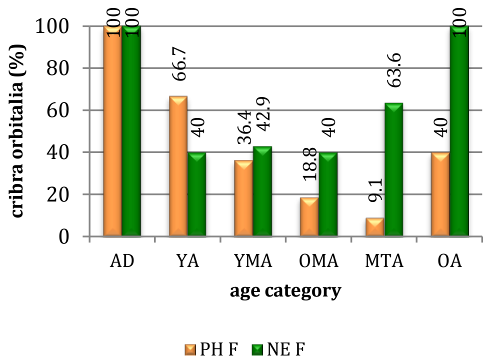


Fig. 6.9: Cribra orbitalia rates in the female samples from Pleidelsheim and Neresheim

When contrasting the prevalence rates of CO, not only does it become evident that individuals in Neresheim altogether show significantly higher rates of this condition than in Pleidelsheim ($\chi^2 = 5.686$, df = 1, N = 180, p = .017*), but that this difference is rooted in the female sample (PH F: 30.2 % vs. NE F: 50 %, $\chi^2 = 4.367$, df = 1, N = 107, p = .037*; Table 6.11; Table 6.9).

Also in the case of DEH, there is a statistically significant difference between the prevalence of the condition in males and females (Fig. 6.10 and Fig. 6.11; Table 6.12), with individuals in Neresheim showing evidence of considerably higher prevalence rates than those in Pleidelsheim ($\chi^2 = 12.779$, df = 1, N = 176, p = .000*).

Table 6.12: Occurrence of dental enamel hypoplasia in Pleidelsheim and Neresheim

DEH	M PH * NE	F PH * NE	all PH * NE
%	37.8 * 73.1	48.2 * 69.4	43.6 * 70.7
χ2	8.215	4.813	12.779
p	.004**	.028*	.000**

*significance at p<.05 level; **significance at p<.01 level

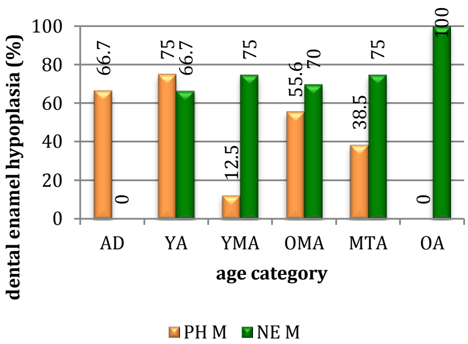


Fig. 6.10: Dental enamel hypoplasia rates in the male samples from Pleidelsheim and Neresheim

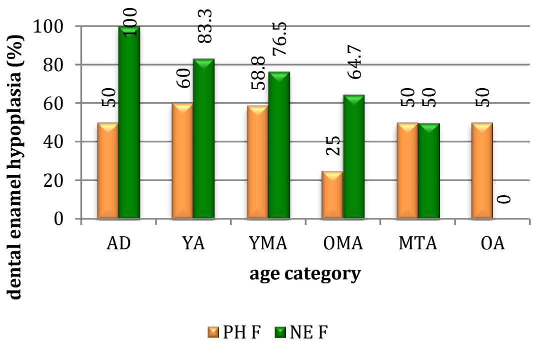


Fig. 6.11: Dental enamel hypoplasia rates in the female samples from Pleidelsheim and Neresheim

Despite these differences in the two populations for the prevalence of either CO or DEH, no statistically significant difference was found for any of the sexes when comparing the combined appearance of childhood stress indicators in both populations (Table 6.13).

Table 6.13: Occurrence of combined childhood stress indicators in Pleidelsheim and Neresheim

CO + DEH	M PH * NE	F PH * NE	all PH * NE
%	23.3 * 34.6	11.9 * 20.4	16.7 * 25.3
χ2	0.869	1.188	1.658
p	.351	.276	.198

*significance at p<.05 level; **significance at p<.01 level

These findings suggest that individuals in Neresheim, especially females, were exposed to generally higher levels of childhood stress than those growing up in Pleidelsheim.

6.1.2.2 Indicators of stress: Non-specific infections

For all skeletal remains from Pleidelsheim and Neresheim, periosteal bone deposition throughout the skeleton was recorded. As the most frequently observed periosteal lesions occurred on the tibia as well as in the maxillary sinus tract, the statistical analysis for variations within and among populations and, thereafter, a correlation with indicators of social status, will focus on tibial periostitis caused by intrinsic or extrinsic factors, such as infectious or metabolic disease, or localized trauma (Ortner 2003 ; Weston 2008), as well as on the prevalence of maxillary sinusitis, a non-specific inflammatory response to upper respiratory tract infection, dental disease or allergies (Boocock *et al.* 1995 ; Lewis *et al.* 1995), with subsequent new bone formation in the sinus cavities.

Tibial periostitis

a) Pleidelsheim

The distribution of tibial periosteal lesions (mostly healed) by age and sex is shown in Table 6.14. Of the total observable population, 14.3 % displayed periosteal reaction of non-specific aetiology on the tibiae, affecting 18.8 % of all males and 10.5 % of all females. Despite this slight trend for males to show higher frequencies of tibial periostitis, no significant difference with regard to sex could be discerned.

It is notable that the condition was only observed as starting to appear in individuals from young middle adulthood onwards (26+ years), with consistent prevalence in both sexes up until old age. It is in the age category of 60+ years that males again show a clear trend for increased levels of tibial periostitis, yet again, this was not found to be significantly different to OA females. Larger sample sizes would be needed for a refined assessment.

Table 6.14: Pleidelsheim - Prevalence of tibial periostitis by age and sex

Age category	tibial periostitis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	0/4	0.0	0/2	0.0	0/6	0.0
YA	0/3	0.0	0/5	0.0	0/8	0.0
YMA	4/14	28.6	3/18	16.7	7/32	21.9
OMA	2/16	12.5	1/21	4.8	3/37	8.1
MTA	3/21	14.3	3/19	15.8	6/40	15.0
OA	3/6	50.0	1/11	9.1	4/17	23.5
Total	12/64	18.8	8/76	10.5	20/140	14.3

A = affected, O = observed

In 66.7% of male cases and 37.5% of female cases, tibial periostitis was observed as occurring unilaterally (Table 6.15), an indicator for localized trauma rather than infectious disease. Despite this trend for males, this difference was not found to be statistically significant.

The reverse ratio, although again not with significant difference, is the case for bilateral manifestation of periosteal lesions (Table 6.15): Females show evidence of both tibiae being affected in 62.5% of cases, while males only show evidence of bilateral distribution in 33.3% of observable cases.

Table 6.15: Pleidelsheim - Distribution of periosteal lesions on the tibia

Distribution	tibial periostitis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
unilaterally	8/12	66.7	3/8	37.5	11/20	55.0
bilaterally	4/12	33.3	5/8	62.5	9/20	45.0

A = affected, O = observed

b) Neresheim

In Neresheim, periosteal changes of the tibia occur in 12.5% of observable cases, with 19.5% of tibial periostitis in males and 8.9% in females (Table 6.16), with no significant difference to be discerned. Interestingly, none of the males in the OA category show evidence of tibial periostitis, while the manifestation in females still amounts to 28.6%.

Table 6.16: Neresheim - Prevalence of tibial periostitis by age and sex

Age category	tibial periostitis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	1/2	50.0	1/2	50.0
YA	0/4	0.0	0/6	0.0	0/10	0.0
YMA	3/5	60.0	1/20	5.0	4/25	16.0
OMA	2/12	16.7	3/26	11.5	5/38	13.2
MTA	3/14	21.4	0/18	0.0	3/32	9.4
OA	0/6	0.0	2/7	28.6	2/13	15.4
Total	8/41	19.5	7/79	8.9	15/120	12.5

A = affected, O = observed

The time of 'onset' of tibial periostitis occurs in young middle adulthood in males. In the female sample, one individual does show evidence of periosteal reactions on the tibia in adolescence, the lesion occurring unilaterally and therefore probably having been caused by external, trauma-related origins rather than infectious disease.

Table 6.17: Neresheim - Distribution of periosteal lesions on the tibia

Distribution	tibial periostitis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
unilaterally	6/8	75.0	5/7	71.4	11/15	73.3
bilaterally	2/8	25.0	2/7	28.6	4/15	26.7

A = affected, O = observed

Males and females in Neresheim show relatively high, and almost similar frequencies for unilateral tibial periostitis (Table 6.17), as opposed to those individuals in Pleidelsheim.

c) Inter-population comparisons

As Table 6.18 indicates, there is no statistically significant difference in the prevalence of tibial periostitis between males and females in Pleidelsheim and Neresheim.

Table 6.18: Comparison of tibial periostitis rates in Pleidelsheim and Neresheim

tibial periostitis	M PH * NE	F PH * NE	all PH * NE
%	18.8 * 19.5	10.5 * 8.9	14.3 * 12.5
$\chi 2$	0.009	0.123	0.177
p	1.000	.726	.674

*significance at p<.05 level; **significance at p<.01 level

It is noteworthy that while unilateral lesions occur less frequently in Pleidelsheim than in Neresheim, bilateral tibial periostitis prevalence is much higher in Pleidelsheim (not statistically significant; Table 6.15, Table 6.17). While in the male samples distributions are similar, in the female samples the patterns are reversed, with females from Neresheim showing considerably higher frequencies of unilateral tibial periostitis than those from Pleidelsheim. Thus despite slightly lower prevalence rates for tibial periostitis in Neresheim altogether, unilateral lesions are much more frequent in this population.

Maxillary sinusitis

a) Pleidelsheim

In Pleidelsheim, twelve out of 140 sinus cavities examined showed bone deposits indicative of maxillary sinusitis (Table 6.19). Between males and females, the ratio of inflammatory bony reaction in the sinus tract remains relatively similar (males 7.8%, females 9.2%), with some individuals of both sexes already affected in adolescence but the main part of the population showing evidence of maxillary sinusitis from about 30 - 40 years of age onwards (although only three cases in the male sample could be observed, hence interpretation must remain cautionary).

Table 6.19: Pleidelsheim - Prevalence of maxillary sinusitis by age and sex

Age category	maxillary sinusitis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	2/4	50.0	0/2	0.0	2/6	33.3
YA	0/3	0.0	0/5	0.0	0/8	0.0
YMA	0/14	0.0	0/18	0.0	0/32	0.0
OMA	0/16	0.0	2/21	9.5	2/37	5.4
MTA	3/21	14.3	2/19	10.5	5/40	12.5
OA	0/6	0.0	3/11	27.3	3/17	17.6
Total	5/64	7.8	7/76	9.2	12/140	8.6

A = affected, O = observed

b) Neresheim

Bone deposits indicating sinusitis could be observed in 14 out of 120 cases (11.7%) in Neresheim (Table 6.20). There is no significant difference in the prevalence of maxillary sinusitis between males and females traceable for this condition in Neresheim, and no case of maxillary sinusitis could be found in the OA category, however, in males, the condition was present from YMA to MTA, while in females it occurred throughout adulthood.

Table 6.20: Neresheim - Prevalence of maxillary sinusitis by age and sex

Age category	maxillary sinusitis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	0/2	0.0	0/2	0.0
YA	0/4	0.0	2/6	33.3	2/10	20.0
YMA	1/5	20.0	1/20	5.0	2/25	8.0
OMA	1/12	8.3	5/26	19.2	6/38	15.8
MTA	2/14	14.3	2/16	12.5	4/32	12.5
OA	0/6	0.0	0/7	0.0	0/13	0.0
Total	4/41	9.8	10/77	13.0	14/118	11.8

A = affected, O = observed

c) Inter-population comparison

A comparison of overall maxillary sinusitis rates between Pleidelsheim and Neresheim (Table 6.21) does not show any significant difference in the prevalence of this non-specific infectious disease, albeit individuals from Neresheim show a slight trend for higher rates of infection than those in Pleidelsheim.

Table 6.21: Comparison of maxillary sinusitis rates in Pleidelsheim and Neresheim

maxillary sinusitis	M PH * NE	F PH * NE	all PH * NE
%	7.8 * 9.8	9.2 * 13.0	14.3 * 11.8
$\chi 2$	0.101	0.442	0.562
p	.738	.506	.454

*significance at p<.05 level; **significance at p<.01 level

Overall, health status measured by rates of non-specific infections does not reveal any significant differences, either within or between the two populations. There are only tendencies for males and females discernible, which may have become more pronounced had the entirety of both cemeteries been available for analysis. Noteworthy at this stage is the differential picture in uni- and bilateral appearance of tibial periostitis in the two populations, considering the discussion about possible etiologies for periosteal reactions on the tibia, the most popular, albeit never demonstrated contention that localized tibial periostitis may be related to habitual horseback riding (Alciati *et al.* 1987 ; Obertová 2008: 178).

6.1.2.3 Vertebral degenerative joint disease

Degenerative changes observed in the vertebral column and discussed in the following analysis comprise:

- spondylosis,
- spondyloarthrosis,
- Schmorl's nodes,
- spondylolysis.

All of these pathological changes can be the result of a number of factors, among them age and weight-bearing (Knüsel *et al.* 1997 ; Ortner 2003), but also the exertion of strenuous activities during a lifetime (Jurmain 1999). Other degenerative changes, either resulting from stress on the spine, such as Scheuerman's Disease, spondylolisthesis and trauma-induced ankylosis, or congenital abnormalities, such as spina bifida occulta, were recorded but only find mention in particular cases, as their occurrence was very rare and does not lend itself for a population-based analysis.

Due to the high degree of fragmentation, degenerative changes of the vertebral column were recorded by vertebral region (i.e. cervical, thoracic, lumbar and sacral) and are presented on a presence / absence basis hereafter, as this analysis aims at a general description and comparison of their occurrence, with a view to subsequent comparison in the funerary context.

Spondylosis

Degenerative changes of the cervical region, i.e. *spondylosis cervicalis*, occurred relatively frequently in in both populations, in most cases in combination with other degenerative joint disease, and can be found listed separately and in detail in Tables 5 (Pleidelsheim) and 6 (Neresheim) in App. 6.

a) Pleidelsheim

Table 6.22 describes the prevalence of spondylosis in Pleidelsheim according to age and sex. In 53.6% of individuals, there is evidence of this condition, with almost equal frequencies in males (51.9%) and females (55.2%).

Table 6.22: Pleidelsheim - Prevalence of spondylosis by age and sex

Age category	spondylosis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	0/4	0.0	0/1	0.0	0/5	0.0
YA	0/3	0.0	0/3	0.0	0/6	0.0
YMA	3/12	25.0	3/11	27.3	6/23	26.1
OMA	7/14	50.0	14/16	87.5	21/30	70.0
MTA	12/15	80.0	8/17	47.1	20/32	62.5
OA	6/6	100.0	7/10	70.0	13/16	81.3
Total	28/54	51.9	32/58	55.2	60/112	53.6

A = affected, O = observed

While the onset of spondylosis could not be observed before young middle adulthood in this sample, its prevalence increases with progressing age - all observable cases of OA males show spondylosis in their vertebral columns, whereas a peak of this condition can be identified in OMA females (87.5%, Table 6.22), and still a prevalence of 70% in females over 60 years of age.

b) Neresheim

In Neresheim, we are presented with an almost identical picture regarding the occurrence of spondylosis (Table 6.23): 53.4 % of the observable population shows this degenerative disease, with 54.8% of males and 52.4% of females.

Table 6.23: Neresheim - Prevalence of spondylosis by age and sex

Age category	spondylosis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	-	-	-	-
YA	0/2	0.0	0/4	0.0	0/6	0.0
YMA	1/4	25.0	1/7	14.3	2/11	18.2
OMA	3/9	33.3	7/15	46.7	10/24	41.7
MTA	9/12	75.0	11/12	91.7	20/24	83.3
OA	4/4	100.0	3/4	75.0	7/8	87.5
Total	17/31	54.8	22/42	52.4	39/73	53.4

A = affected, O = observed

Again, spondylosis does not emerge before young middle adulthood and intensifies with age, in this case with the highest frequency of spondylosis in females during mature adulthood.

c) Inter-population comparisons

Unsurprisingly, a direct comparison of spondylosis rates between Pleidelsheim and Neresheim resulted in no significant difference regarding the prevalence of this degenerative disease (Table 6.24). Distribution rates are almost equal in every case, i.e. of sex as well as of age category.

Table 6.24: Comparison of spondylosis rates in Pleidelsheim and Neresheim

spondylosis	M PH * NE	F PH * NE	all PH * NE
%	51.9 *54.8	55.2 * 52.4	53.6 * 53.4
χ2	0.071	0.076	0.000
p	.791	.782	.984

*significance at p<.05 level; **significance at p<.01 level

Spondyloarthrosis

The occurrence of spondyloarthrosis, i.e. degenerative changes of the apophyseal joints of the vertebrae (Ortner 2003), was present in both populations, although with moderately lower prevalence rates than spondylosis.

a) Pleidelsheim

In the Pleidelsheim sample, 26 out of 106 vertebral columns (24.%) display evidence of spondyloarthrosis (Table 6.25), with males (30.8%) more often than females (18.5%), yet not statistically significantly so.

Table 6.25: Pleidelsheim - Prevalence of spondyloarthrosis by age and sex

Age category	spondyloarthrosis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	0/4	0.0	0/1	0.0	0/5	0.0
YA	0/3	0.0	0/3	0.0	0/6	0.0
YMA	0/11	0.0	0/11	0.0	0/22	0.0
OMA	4/12	33.3	3/14	21.4	7/26	26.9
MTA	8/17	47.1	1/15	6.7	9/32	28.1
OA	4/5	80.0	6/10	60.0	10/15	66.7
Total	16/52	30.8	10/54	18.5	26/106	24.5

A = affected, O = observed

There is, however, a significant difference in the occurrence of spondyloarthrosis between males and females during mature adulthood (N = 32, FET, p = .018*), with males showing a significantly higher prevalence of this condition (relative frequency 47.1%) than females (relative frequency 6.7%), and in general higher frequencies in any given age category after the first identifiable appearance of the condition from about 36+ years of age (OMA; Fig. 6.12).

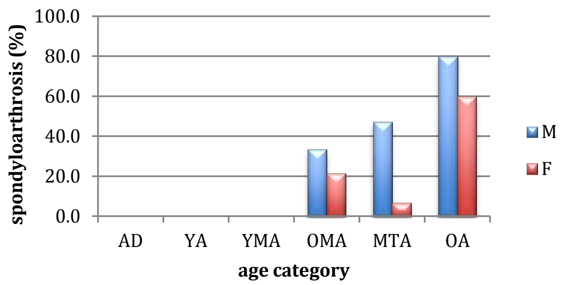


Fig. 6.12: Prevalence of spondyloarthrosis in males and females from Pleidelsheim

b) Neresheim

In the sample from Neresheim, no significant difference in the prevalence of spondyloarthrosis could be discerned between males and females, although males show slightly higher rates of the condition than females (36.7% vs. 20.9%; Table 6.26).

Table 6.26: Neresheim - Prevalence of spondyloarthrosis by age and sex

Age category	spondyloarthrosis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	-	-	-	-
YA	0/2	0.0	0/4	0.0	0/6	0.0
YMA	0/4	0.0	0/8	0.0	0/12	0.0
OMA	0/8	0.0	3/15	20.0	3/23	13.0
MTA	8/12	66.7	4/12	33.3	12/24	50.0
OA	3/4	75.0	2/4	50.0	5/8	62.5
Total	11/30	36.7	9/43	20.9	20/73	27.4

A = affected, O = observed

The onset of spondyloarthrosis among the male population could only be established in the MTA age category (46+ years), however then with remarkably high prevalence rates (66.7%), while in females, a constant increase from old middle adulthood onwards was observed (Table 6.26).

c) Inter-population comparisons

A comparison of spondyloarthrosis rates in Pleidelsheim and Neresheim revealed no statistically significant difference between the male and female samples (Table 6.27). In both populations, this type of degeneration of the spine followed a similar course throughout life, with males from Neresheim showing this condition slightly more frequently than males from Pleidelsheim.

Table 6.27: Comparison of spondyloarthrosis rates in Pleidelsheim and Neresheim

spondyloarthrosis	M PH * NE	F PH * NE	all PH * NE
%	30.8 * 36.7	18.5 * 20.9	24.5 * 27.7
χ2	0.300	0.088	0.186
p	.584	.766	.666

*significance at p<.05 level; **significance at p<.01 level

Spondylolysis

Only few occurrences of spondylolysis, i.e. the partial or complete separation of the neural arch from the vertebral body, were found among the observable skeletons from Pleidelsheim and Neresheim. This condition usually occurs in the lumbar region, and while its aetiology can be related to genetic factors, it is much more likely related to stress and thus forms as a result of a fatigue fracture in the lower vertebral region (Merbs 1996 ; Ortner 2003). Therefore, individual occurrences of spondylolysis will be considered in the context of activity-related changes, while an overview of prevalence in Pleidelsheim and Neresheim is displayed below.

a) Pleidelsheim

In 97 observable skeletons from Pleidelsheim, spondylolysis could only be identified in two cases (Table 6.28), in an YMA male and an OA female. In both instances, it was a case of partial spondylolysis (Fig. 6.13).

Table 6.28: Pleidelsheim - Prevalence of spondylolysis by age and sex

Age category	spondylolysis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	0/1	0.0	0/1	0.0	0/5	0.0
YA	0/3	0.0	0/3	0.0	0/6	0.0
YMA	1/11	9.1	0/11	0.0	1/22	4.5
OMA	0/12	0.0	0/13	0.0	0/25	0.0
MTA	0/12	0.0	0/14	0.0	0/26	0.0
OA	0/5	0.0	1/8	12.5	1/13	7.7
Total	1/47	2.1	1/50	2.0	2/97	2.1

A = affected, O = observed

Fig. 6.13: Partial spondylolysis in Skel. PH 225 (OA female, chamber burial)

b) Neresheim

In Neresheim, a total of six cases (9%) of spondylolysis could be identified (Table 6.29), with three cases among the male sample (11.1%) and three among the female sample (7.5%).

Table 6.29: Neresheim - Prevalence of spondylolysis by age and sex

Age category	spondylolysis					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	-	-	-	-
YA	1/2	50.0	0/4	0.0	1/6	16.7
YMA	2/4	50.0	0/8	0.0	2/12	16.7
OMA	0/8	0.0	2/14	14.3	2/22	9.1
MTA	0/10	0.0	0/11	0.0	0/21	0.0
OA	0/3	0.0	1/3	33.3	1/6	16.7
Total	3/27	11.1	3/40	7.5	6/67	9.0

A = affected, O = observed

While the male individuals showing this condition are found in the age categories spanning from *c.* 18 - 35 years, in females, spondylolysis was observed in the old middle and old adult range (Table 6.29), i.e. despite the very low numbers, in a similar pattern to that noted at Pleidelsheim.

c) Inter-population comparisons

The low frequencies of spondylolysis did not qualify for any significance testing. There is a tendency, however, for individuals from Neresheim to exhibit a higher prevalence of spondylolysis (9 % of the total population from Neresheim, as opposed to 2.1% of the total population from Pleidelsheim; Fig. 6.14).

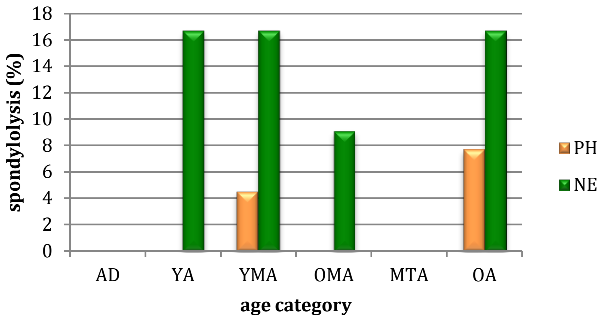


Fig. 6.14: Spondylolysis rates in the total samples from Pleidelsheim and Neresheim

Schmorl's nodes

Schmorl's nodes (hereafter: SN), associated with vertebral disc degeneration caused by stress upon the spine, were most frequently observed in the lower thoracic and upper lumbar vertebrae, concurrent with axial compression and movement as the most likely cause (Knüsel 2000a).

a) Pleidelsheim

In the Pleidelsheim sample, SN were observed in 58.7% of cases (Table 6.30).

Table 6.30: Pleidelsheim - Prevalence of Schmorl's nodes by age and sex

Age category	Schmorl's nodes					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	2/4	50.0	0/1	0.0	2/5	40.0
YA	2/3	66.7	1/3	33.3	3/6	50.0
YMA	2/8	25.0	4/11	36.4	6/19	31.6
OMA	9/11	81.8	7/12	58.3	16/23	69.6
MTA	12/14	85.7	8/13	61.5	20/27	74.1
OA	4/5	80.0	3/7	42.9	7/12	58.3
Total	31/45	68.9	23/47	48.9	54/92	58.7

A = affected, O = observed

There is a significant difference in the occurrence of SN between males and females (χ^2 = 3.775, df = 1, N = 92, p = .052$^{(*)}$), with males showing altogether a higher prevalence rate (relative frequency = 68.0%) than females (relative frequency = 48.9%; Table 6.30; Fig. 6.15). The onset of the condition in males seems to have happened earlier - already in adolescence, two cases could be observed -, and its frequency is consistently higher than in females throughout all age categories (Table 6.30). The appearance of SN already during adolescence and young adulthood, coupled with an increase with age in both sexes, suggests that in this population, they can be both an activity- and age-related phenomenon.

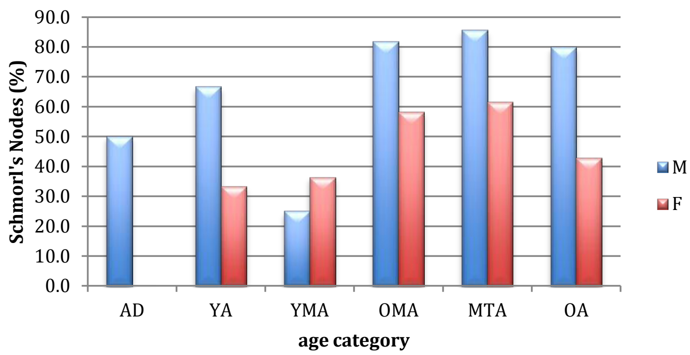


Fig. 6.15: Prevalence of Schmorl's nodes in males and females from Pleidelsheim

b) Neresheim

The population from Neresheim shows an overall prevalence of 45.2 % of SN (Table 6.31).

Table 6.31: Neresheim - Prevalence of Schmorl's nodes by age and sex

Age category	Schmorl's nodes					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	-	-	-	-
YA	2/2	100.0	0/3	0.0	2/5	40.0
YMA	2/4	50.0	2/6	33.3	4/10	40.0
OMA	4/8	50.0	4/12	33.3	8/20	40.0
MTA	8/9	88.9	2/11	18.2	10/20	50.0
OA	3/4	75.0	1/3	33.3	4/7	57.1
Total	19/27	70.4	9/35	25.7	28/62	45.2

A = affected, O = observed

There is a highly significant difference in the occurrence of SN between males and females in Neresheim (χ^2 = 12.273, df = 1, N = 62, p = .000**), with males showing significantly higher prevalence rates for this condition (relative frequency = 70.4%) compared to females (relative frequency = 25.7%).

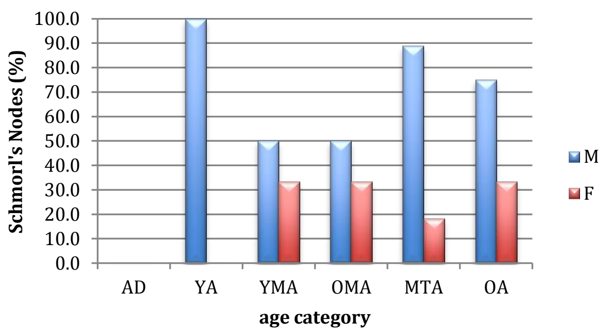


Fig. 6.16: Prevalence of Schmorl's nodes in males and females from Neresheim

As Fig. 6.16 shows, males display SN already from young adulthood onwards, with increasing prevalence with advancing age. In females, SN could only be identified from circa 26 years of age onwards, maintaining comparatively low levels of this type of degenerative change of the vertebral column, with no visible increase in frequency with age. Despite the relatively low number of observable cases, this could suggest that in females in this population, the occurrence of SN is an activity-related, rather than age-related phenomenon.

c) Inter-population comparisons

A comparison of both populations revealed a statistically significant difference in the prevalence of Schmorl's nodes between females (χ^2 = 4.546, df = 1, N = 82, p = .033*) in Pleidelsheim and Neresheim (Table 6.32), with females in Pleidelsheim showing evidence of higher prevalence rates (relative frequency = 48.9%) than in Neresheim (relative frequency = 25.7%), especially from old middle adulthood onwards (Fig. 6.17).

Table 6.32: Comparison of Schmorl's nodes rates in Pleidelsheim and Neresheim

Schmorl's nodes	M PH * NE	F PH * NE	all PH * NE
%	68.9 * 70.4	48.9 * 25.7	58.7 * 45.2
χ2	0.017	4.546	2.725
p	.895	.033*	.099

*significance at p<.05 level; **significance at p<.01 level

In males, the overall prevalence of SN is comparable, although the condition possibly appeared earlier in young men from Pleidelsheim (Fig. 6.18).

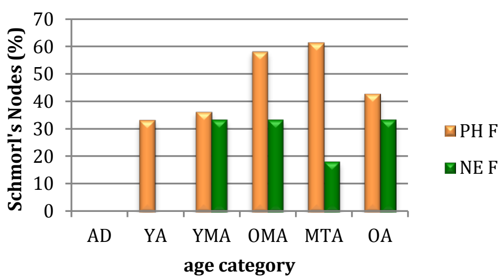


Fig. 6.17: Schmorl's nodes rates in the female samples from Pleidelsheim and Neresheim

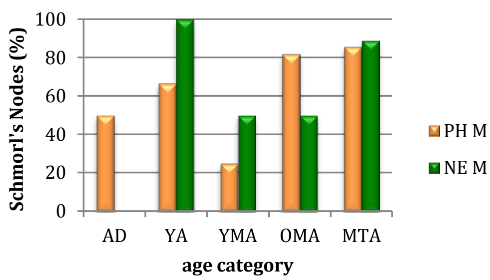


Fig. 6.18: Schmorl's nodes rates in the male samples from Pleidelsheim and Neresheim

In conclusion, the results regarding intra- and inter-population differences for vertebral degenerative joint disease are varied. Conditions with multiple possible etiologies, such as spondylosis, occur in equal measure in the cemetery populations of Pleidelsheim and Neresheim. Pathological changes that could be primarily related to physical degeneration, i.e. spondyloarthrosis and SN, but also, to a certain extent, spondylolysis (although the numbers observed here are too low for any differential interpretation), show distinctive differences: males display higher frequencies of spondyloarthrosis than females in both populations, in Pleidelsheim in combination with higher rates of SN. Females from Pleidelsheim show increased rates of vertebral degeneration (characterized by SN) compared to those from Neresheim.

6.1.2.4 Extra-vertebral degenerative joint disease and osteoarthritis

Degenerative changes to extra-vertebral articular joint surfaces, caused and influenced by a range of intrinsic and extrinsic factors relating to age, sex and activity levels of the individual (Knüsel 2000a) as well as to stress factors associated with the living environment (Jurmain 1977), were recorded using the criteria for degenerative joint disease (hereafter: DJD) and osteoarthritis (hereafter: OA) proposed by Rogers and Waldron (1995) for all observable joint surfaces on a presence / absence basis for the following joint complexes:

- **temporo-mandibular joint** (TMJ)
- **shoulder**: Cl - acromioclavicular and sternoclavicular joint surfaces; Sc - glenoid fossa; Hu - humeral head

- **elbow**: Hu - distal articulation; Ra - proximal joint surface; Ul - proximal joint surface
- **wrist / hand (pooled)**: Ra - distal articulation; Ul - distal articulation; carpals; hand: carpometacarpal, metacarpophalangeal, proximal and distal interphalangeal joints
- **hip**: Fe - femoral head; Ossa coxae - acetabulum
- **knee**: patella; Fe - distal articulation; Ti - medial and lateral epicondyle
- **ankle / foot (pooled)**: Ti - distal articular surface; tarsals; foot: tarsometatarsal, metatarsophalangeal, proximal and distal interphalangeal joints.

For all joints, data on the right and left sides were recorded and analysed separately (cf. Buikstra and Ubelaker 1994). Considering that only eburnation, i.e. the loss of joint-space height between joints with advanced joint and articular degeneration to a bone-on-bone contact level, can be taken as a definite sign for osteoarthritis (Rogers and Waldron 1995 ; Aufderheide and Rodriguez-Martín 1998 ; Jurmain 1999), suggesting excessive and continuing activity (when found in younger individuals) and stress to the joint, it was decided to differentiate between DJD and OA on the basis of the presence of eburnation. Therefore, the analysis for 'extra-vertebral DJD' describes the presence of degenerative joint disease, although not necessarily osteoarthritis, i.e. if marginal osteophyte formation and porosity / pitting of the joint surface with or without osteophyte formation were observed, but no eburnation. The examination for OA presents cases of (severe) osteoarthritis, marked by eburnation of one or more joint surfaces.

Observations in the sacro-iliac joint were scored as well but are not listed here, as too few incidences were recorded and are considered on a case-by-case basis for conditions such as sacro-iliitis or ankylosing spondylitis (AS) (Rogers *et al.* 1987), if bilateral presence of changes to the sacro-iliac joint could be observed.

For the population analysis of overall prevalence ratios of DJD, including analyses of funerary correlates later in this chapter, only the appendicular skeleton was included, because the inclusion of TMJ DJD would have skewed the results.

a) Pleidelsheim

Extra-vertebral DJD

The distribution of degenerative changes by joint for males and females in Pleidelsheim is shown in Table 6.33.

Table 6.33: Pleidelsheim - Prevalence of extra-vertebral DJD by joint, side and sex

Joint	side	M		F		Total	
		A/O	%	A/O	%	A/O	%
TMJ	R	2/42	4.8	3/50	6.0	5/92	5.4
	L	0/41	0.0	5/52	9.6	5/93	5.4
shoulder	R	14/48	29.2	7/48	14.6	21/96	21.9
	L	9/43	20.9	5/43	11.6	14/86	16.3
elbow	R	3/40	7.5	2/42	4.8	5/82	6.1
	L	3/42	7.1	3/43	7.0	6/85	7.1
wrist / hand	R	5/39	12.8	0/39	0.0	5/78	6.4
	L	5/39	12.8	0/40	0.0	5/79	6.3
hip	R	28/52	53.8[a)**]	28/57	49.1[b)*]	56/109	51.4
	L	14/50	28.0	16/55	29.1	30/105	28.6
knee	R	1/45	2.2	4/52	7.7	5/97	5.2
	L	1/44	2.3	4/51	7.8	5/95	5.3
ankle / foot	R	1/48	2.1	0/49	0.0	1/97	1.0
	L	5/48	10.4	0/47	0.0	5/95	5.4

A = affected, O = observed

[a)] M exhibit significantly more DJD in the right hip, compared to the left (χ^2 = 7.030, df = 1, N = 102, p = .008**).

[b)] F exhibit significantly more DJD in the right hip, compared to the left (χ^2 = 4.709, df = 1, N = 112, p = .030*).

*significance at p<.05 level; **significance at p<.01 level

Overall, we can observe the highest frequencies of degenerative changes in the hip, followed by the shoulder, the wrist/hand complex and the elbow, the knees, and finally the ankle/foot complex (Table 6.33). Except for wrist, hand, ankle and foot joints, no statistically significant difference between males and females could be discerned in any affected joint. In the shoulder, females show slightly lower rates of DJD than males, in the knee, slightly higher prevalence, while articular degeneration in the elbow is similar in the sexes.

Considering the joints of wrist and hand as well as of ankle and foot, interestingly, only males show degenerative changes (Table 6.33). Given the often described suggestion that Alamannic women might have strained their wrist and hand joints by continual work at the loom, by spinning and weaving (e.g. Bank-Burgess 1997), this observation may either point in a very different interpretation from this pre-conception, or a constancy in such activity may have protected these joints from the effects of DJD, due to high and constant levels of activity and movements, a factor that has to be considered regarding the complex aetiopathogenesis of osteoarthritic development (Jurmain 1999 ; Weiss and Jurmain 2007). The latter implication can be corroborated by the findings from a skeletal sample of individuals with known occupation 'weavers' from Christ Church, Spitalfields (18^{th}/19^{th} c.) that found no degenerative changes to the joints of the hands of people with this occupation (Waldron and Cox 1989).

Observing the laterality of joint manifestations, for both males and females, there is significantly more DJD in the right hip than in the left (Table 6.33). This concurs with previous findings (e.g. Waldron 1997), however, an explanation for this phenomenon could not be supported and will, in the present case, be approached at a later point by following up possible interdependencies with artefactual correlates. Regarding other joints, we can see slightly more degeneration in the right shoulder than the left in both sexes, and, in females, slightly more degeneration in the left elbow than the right (Table 6.33).

Overall, males exhibit significantly higher rates of DJD at Pleidelsheim than do females throughout the adult life course (χ^2 = 4.139, df = 1, N = 140, p = .042*; Table 6.34).

Table 6.34: Pleidelsheim - Prevalence of extra-vertebral DJD by age and sex

Age category	extra-vertebral degenerative joint disease					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	3/4	75.0	1/2	50.0	4/6	66.7
YA	3/4	75.0	3/5	60.0	6/9	66.7
YMA	11/13	84.6	8/18	44.4	19/31	61.3
OMA	14/17	82.4	15/20	75.0	29/37	78.4
MTA	14/20	70.0	13/21	61.9	27/41	65.9
OA	5/5	100.0	9/11	81.8	14/16	87.5
Total	50/63	79.4	49/77	63.6	99/140	70.7

A = affected, O = observed

As the distribution shows (Fig. 6.19), this remains the case throughout life, with a statistically significant difference between the sexes in the YMA category (c. 26 - 35 years; χ^2 = 5.134, df = 1, N = 31, p = .023*).

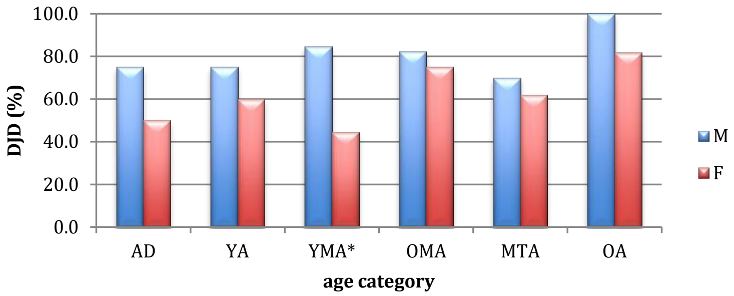


Fig. 6.19: Pleidelsheim - Prevalence of DJD by age and sex

While age clearly is a crucial factor in the development for DJD (Jurmain 1977), with an increase of DJD with advancing age that can also be observed here (Table 6.34; Fig. 6.19), figures regarding the prevalence of DJD in Pleidelsheim in adolescents and young adults are relatively high (despite the overall low numbers of observable cases), indicating that factors other than age may be influencing the development of DJD.

(Severe) Osteoarthritis

Among the males, five cases of severe OA (i.e. with evidence of eburnation), among the females, two cases could be identified, i.e. evidence of severe OA was found in 5% of the total sample (Table 6.35). While for females, OA occurred in the left elbow joint and the left hip joint, in males we find OA present in the left shoulder and the right elbow, the left wrist / hand joint complex and left ankle / foot joint complex, as well as in the left hip joint.

Table 6.35: Pleidelsheim - Prevalence of (severe) OA by age and sex

Age category	severe osteoarthritis (extra-vertebral)					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	0/4	0.0	0/2	0.0	0/6	0.0
YA	0/4	0.0	0/5	0.0	0/9	0.0
YMA	0/12	0.0	0/18	0.0	0/30	0.0
OMA	1/17	5.9	0/20	0.0	1/37	2.7
MTA	3/20	15.0	1/21	4.8	4/41	9.8
OA	1/5	20.0	1/11	9.1	2/16	12.5
Total	5/62	8.1	2/77	2.6	7/139	5.0

A = affected, O = observed

The onset of OA seems to arise during old middle adulthood, with continuous progression afterwards. There is no significant difference regarding the occurrence of severe OA between males and females in Pleidelsheim at any age.

b) Neresheim

Extra-vertebral DJD

Table 6.36 shows the distribution of degenerative changes by joint for males and females in Neresheim. Most commonly affected by DJD are the shoulder joints, followed by the hips. In both cases, males display higher frequencies than females, in case of the right hip significantly so (Table 6.36). Wrist / hand and elbow joints follow, the latter with higher frequencies in females than in males, then the knee joints and the ankle / foot joint complex. It is worth mentioning that, as opposed to Pleidelsheim, the prevalence rate for TMJ DJD surpasses the 10% mark in the Neresheim population.

Table 6.36: Neresheim - Prevalence of extra-vertebral DJD by joint, side and sex

Joint	side	M		F		Total	
		A/O	%	A/O	%	A/O	%
TMJ	R	3/27	11.1	5/45	11.1	8/72	11.1
	L	3/18	16.7	5/44	11.4	8/62	12.9
shoulder	R	10/27	37.0	10/46	21.7[b)*]	20/73	27.4
	L	5/27	18.5	3/46	6.5	8/73	11.0
elbow	R	1/29	3.4	5/44	11.4	6/73	8.2
	L	1/29	3.4	3/37	8.1	4/66	6.1
wrist / hand	R	3/21	14.3	2/33	6.1	5/54	9.3
	L	1/21	4.8	2/26	7.7	3/47	6.4
hip	R	11/33	33.3[a)**]	3/41	7.3	14/74	18.9
	L	6/29	20.7	4/45	8.9	10/74	13.5
knee	R	1/27	3.7	1/41	2.4	2/68	2.9
	L	1/20	5.0	1/37	2.7	2/57	3.5
ankle / foot	R	1/25	4.0	0/42	0.0	1/67	1.5
	L	0/26	0.0	1/45	2.2	1/71	1.4

A = affected, O = observed

[a)] M display significantly more DJD in the right hip joint than females (χ^2 = 8.068, df = 1, N = 74, p = .005**).

[b)] F exhibit significantly more DJD in the right shoulder, compared to the left (χ^2 = 4.389, df = 1, N = 59, p = .036*) (no sign. diff. in M).

*significance at p<.05 level; **significance at p<.01 level

In this population, women do show degenerative changes to their wrists and hands as well as ankles and feet, even though in the latter this is limited to only one individual, as is also the case in males.

Regarding laterality, we do not find significant preponderance of DJD of the right hip; in the female sample, the reverse, in actuality, seems to be the case (Table 6.36). Females show a significant difference in prevalence of degenerative changes in the shoulder joints, with the right shoulder being much more affected than the left.

An overview of DJD in males and females across the age categories (Table 6.37) presents us with the same pattern as in Pleidelsheim: males show significantly more DJD than females (χ^2 = 4.819, df = 1, N = 106, p = .028*).

Table 6.37: Neresheim - Prevalence of extra-vertebral DJD by age and sex

Age category	extra-vertebral degenerative joint disease					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	0/1	0.0	0/1	0.0
YA	1/4	25.0	0/6	0.0	1/10	10.0
YMA	2/5	40.0	3/15	20.0	5/20	25.0
OMA	6/12	50.0	8/22	36.4	14/34	41.2
MTA	9/13	69.2	5/17	29.4	14/30	46.7
OA	2/5	40.0	4/6	66.7	7/11	63.6
Total	20/39	51.3	20/67	29.9	41/106	38.7

A = affected, O = observed

Again, an increase of DJD with advancing age is evident (Fig. 6.20), with females in old age (60+ years) seeming to display even more DJD than do males, although the numbers of observable cases are too small for any further insights.

During mature adulthood, prevalence rates of DJD are significantly higher in males than in females (χ^2 = 4.693, df = 1, N = 30, p = .03*; Fig. 6.20).

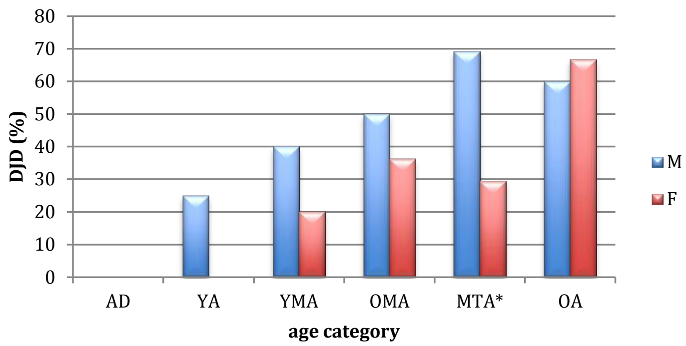


Fig. 6.20: Neresheim - Prevalence of DJD by age and sex

(Severe) Osteoarthritis

In Neresheim, we are presented with six cases of OA among the male sample, and with five cases of OA among the female sample. While both sexes exhibit indications of severe OA in the wrist and hands joint complex, as well as the knees, also one female case was found for the right elbow joint.

Table 6.38: Neresheim - Prevalence of (severe) OA by age and sex

Age category	severe osteoarthritis (extra-vertebral)					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	0/1	0.0	0/1	0.0
YA	0/4	0.0	0/6	0.0	0/10	0.0
YMA	0/5	0.0	0/15	0.0	0/20	0.0
OMA	0/12	0.0	2/22	9.1	2/34	5.9
MTA	2/13	15.4	1/17	5.9	3/30	10.0
OA	1/5	20.0	1/6	16.7	2/11	18.2
Total	3/39	7.7	4/67	6.0	7/106	6.6

A = affected, O = observed

Also in this population, the age of onset of OA can be suggested for old middle adulthood, with a progression of pathological changes through to old age.

c) Inter-population comparisons

Table 6.39 summarizes the prevalence for extra-vertebral degenerative changes of the observed joint complexes in Pleidelsheim and Neresheim and puts the two populations in direct comparison.

Table 6.39: Rates of DJD by joint, side and sex in Pleidelsheim and Neresheim

Joint		Males				Females			
		Pleidelsheim		Neresheim		Pleidelsheim		Neresheim	
		right	left	right	left	right	left	right	left
shoulder	**%**	29.2	20.9	37.0	18.5	14.6	11.6	21.7[2]	6.5
	n	48	43	27	27	48	43	46	46
elbow	**%**	7.5	7.1	3.4	3.4	4.8	7.0	11.4	8.1
	n	40	42	29	29	42	43	44	37
wrist / hand	**%**	12.8	12.8	14.3	4.8	0.0	0.0	6.1	7.7
	n	39	39	21	21	39	40	33	26
hip	**%**	53.8[2]	28.0	33.3[1]	20.7	49.1[2, 3]	29.1[3]	7.3	8.9
	n	52	50	33	29	57	55	41	45
knee	**%**	2.2	2.3	3.7	5.0	7.7	7.8	2.4	2.7
	n	45	44	27	20	52	51	41	37
ankle / foot	**%**	2.1	10.4	4.0	0.0	0.0	0.0	0.0	2.2
	n	48	48	25	26	49	47	42	45

A = affected, O = observed
% = percentage of individuals with extra-vertebral DJD; n = sample size for that group
[1]The prevalence of DJD is significantly higher ($p < .05$) in M than in F.
[2]The prevalence of DJD is significantly higher ($p < .05$) on one side compared with the other (with the position of [2] signifying the side with significantly more DJD).
[3]The prevalence of DJD is significantly higher ($p < .05$) in Pleidelsheim.

In addition to the intrapopulation differences before, it emerges in the comparison between the two sites that females from Pleidelsheim show statistically significantly more DJD of the hip (bilaterally) than females from Neresheim (right hip: χ^2 = 19.272, df = 1, N = 98, p = .000**; left hip: χ^2 = 6.313, df = 1, N = 100, p = .012**). Also the knee joints seem to be more affected, but not significantly so. A look at overall numbers in both populations reveals that in general, and in females even more so than in males, individuals from Pleidelsheim show significantly higher rates of DJD than those from Neresheim (Table 6.40; Fig. 6.21).

Table 6.40: Comparison of DJD rates in Pleidelsheim and Neresheim

extra-vertebral DJD	M PH * NE	F PH * NE	all PH * NE
%	79.4 * 51.3	63.6 * 29.9	70.7 * 38.7
χ2	8.824	16.386	26.695
p	.003**	.000**	.000**

*significance at p<.05 level; **significance at p<.01 level

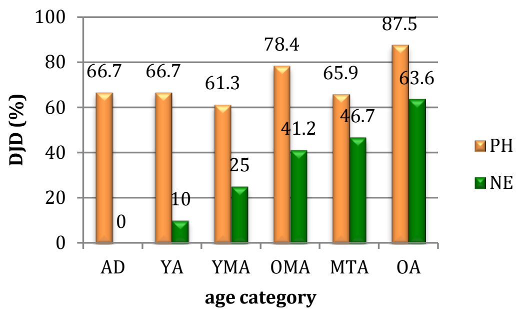


Fig. 6.21: DJD rates in the total samples of Pleidelsheim and Neresheim

With regard to the few cases of severe OA that were observed at Pleidelsheim and Neresheim, no significant differences between both populations could be discerned (Table 6.41).

Table 6.41: Comparison of OA rates in Pleidelsheim and Neresheim

severe OA	M PH * NE	F PH * NE	all PH * NE
%	8.1 * 7.7	2.6 * 6.0	5.0 * 6.6
χ2	0.005	1.021	0.274
p	.946	.312	.600

*significance at p<.05 level; **significance at p<.01 level

In general, the patterns revealed for extra-vertebral DJD and OA complement the observations made for degenerative and arthritic changes in the vertebral column:

articular degeneration is significantly higher in males than in females in both populations, and individuals from Pleidelsheim, in particular females, show evidence of remarkably higher rates of DJD than those from Neresheim.

In more detail, we recognize differential patterns between the two populations, with regard to the distribution of DJD as well as the male - female dichotomy. It is conspicuous that pathological changes of the joints and vertebral column are not solely related to age but, given the differential prevalences, to factors perhaps related to variability in activity and environment.

6.1.2.5 Dental pathologies

The prevalence of caries, antemortem tooth loss (AMTL), peri-apical disease (abscesses, cysts) and periodontal disease (periodontitis) were recorded by tooth or dental alveolus and assessed by individual on a presence / absence basis.

As only a general assessment of the differences in the occurrence of dental disease is of interest for this study and will be considered later with regard to different burial modes as possible indicators for social differentiation, the results of the individual-count method are described briefly below (Tables 6.42 - 6.44).

Table 6.42: Dental pathology frequencies (%) in comparison: total populations

	Pleidelsheim	Neresheim
caries	49.6	38.1
peri-apical disease	14.8	6.7
periodontal disease	14.8 [a)]	11.4
AMTL	20.7	51.4 [b)]

[a)] significantly higher in PH than in NE (p = .048*); [b)] significantly higher in NE than in PH (p = .000**)

Table 6.43: Dental pathology frequencies (%) in comparison: Males

	Pleidelsheim	Neresheim
caries	50.8	53.8
peri-apical disease	13.1	11.1
periodontal disease	14.8	16.7
AMTL	29.5 [a) b)]	50.0

[a)] significantly higher in PH M than in PH F (p = .023*); [b)] significantly higher in NE M than PH M (p = .044*)

Table 6.44: Dental pathology frequencies (%) in comparison: Females

	Pleidelsheim	Neresheim
caries	48.6	37.7
peri-apical disease	16.2	4.3
periodontal disease	14.9 [a)]	8.7
AMTL	13.5 [b)]	52.2

[a)] significantly higher in PH F than NE F (p = .021*); [b)] significantly higher in NE F than in PH F (p = .000**)

Table 6.42 presents the frequencies of all four analyzed conditions of dental disease in the total cemetery populations of Pleidelsheim and Neresheim. Caries rates are highest in Pleidelsheim overall, although this difference is leveled when comparing male samples (Table 6.43) and persists in the female samples (Table 6.44). Peri-apical disease, caused by a variety of infections due to, for instance, pulp exposure, caries, severe attrition or trauma (Ogden 2008a) was observed more frequently in Pleidelsheim than in Neresheim (Table 6.42). Again, we find a much higher divergence in prevalence among the female as opposed to the male sample (Table 6.44, Table 6.43).

When considering periodontitis, among other things often due to poor oral hygiene and a soft, carbohydrate-rich diet (Hillson 1996: 319f.), this difference becomes statistically significant when comparing the female samples from Pleidelsheim and Neresheim (Table 6.44), whereas the men from Neresheim exhibit even more indicators of periodontal disease than those from Pleidelsheim (Table 6.43).

Finally, AMTL presents the only case in the category of dental disease in which individuals from Neresheim show a clear, statistically significant prevalence (Table 6.42). In Pleidelsheim, males show this premature loss of teeth, which may have been initiated by a number of causes, including all of the above named conditions, significantly more frequently than females (Table 6.43, Table 6.44). In Neresheim, however, over 50% of the population exhibits AMTL, equally in males and females.

Fig. 6.22: Dental abscess, periodontal disease and AMTL, Skel. NE 106 (f, MTA, 'simple' burial)

6.1.2.6 Trauma

Three different categories of trauma could be observed in the skeletal remains from Pleidelsheim and Neresheim:

- acute injuries: healed or acute (i.e. unhealed) cases of antemortem or peri-mortem trauma, including fractures, blunt-force and sharp-force trauma, of accidental or violent nature, intentional or unintentional;
- trauma due to an underlying pathological process (e.g. stress, osteoporosis) weakening the bone and leading to fractures (i.e. fatigue fractures);
- activity-related trauma due to repetitive or sudden stress, including avulsion fractures and enthesopathies.

All traumata were recorded on a presence / absence basis, by bone, side affected and position of the lesion (Judd and Roberts 1999). A list of descriptions of observed cases and types of trauma, in males and females, can be found in App. 6, Table 7 (Pleidelsheim) and Table 8 (Neresheim).

Although listed in the trauma record, trauma due to mechanical stress (i.e. enthesopathies, avulsion fractures, vertebral compression fractures, spondylolysis and spondylolisthesis) is excluded in the following analysis, which focuses on injuries of accidental and violent character (i.e. fractures, blunt-force and sharp-force injuries).

a) Pleidelsheim

In Pleidelsheim, traumatic lesions were manifest in 27.5% of observable males, almost equally across all adult age categories, and only in 2.9% of observable females (Table 6.45). Thus, there is a significant difference in the prevalence of trauma between the sexes (χ^2 = 16.098, df = 1, N = 132, p = .000**).

Table 6.45: Pleidelsheim - Prevalence of trauma by age and sex

Age category	skeletal trauma					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	0/4	0.0	0/1	0.0	0/5	0.0
YA	1/3	33.3	0/5	0.0	1/8	12.5
YMA	5/13	38.5	0/16	0.0	5/29	17.2
OMA	4/16	25.0	1/20	5.0	5/36	13.9
MTA	6/20	30.0	1/18	5.6	7/38	18.4
OA	1/6	16.7	0/10	0.0	1/16	6.3
Total	17/62	27.5	2/70	2.9	19/132	14.4

A = affected, O = observed

The fractures sustained by the two females comprise a healed phalangeal fracture to the right hand (Skel. PH 47, OMA) as well as a healed fracture of the right mandible (ascending ramus, Skel. PH 196, MTA; App. 6, Table 7).

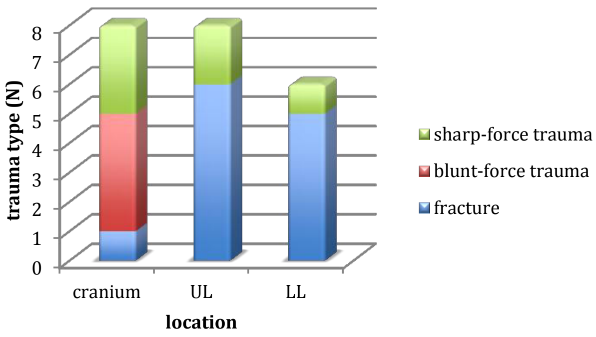


Fig. 6.23: Pleidelsheim - Distribution of trauma types (n° of cases)

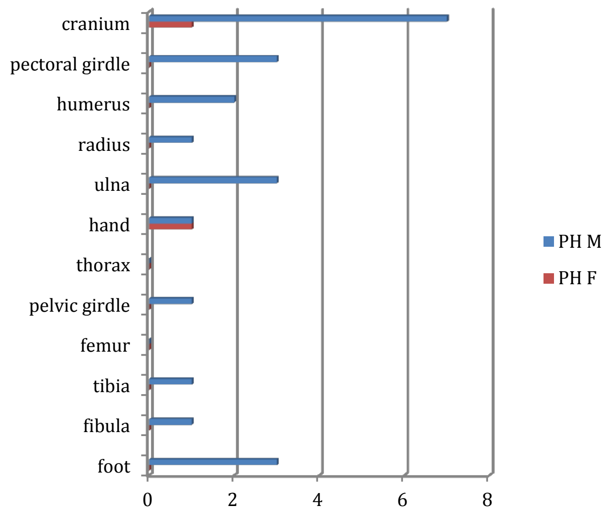


Fig. 6.24: Pleidelsheim - Distribution of trauma (n° of cases) by element

As Fig. 6.23 illustrates, all three types of injury, i.e. healed blunt-force trauma, healed and unhealed sharp-force trauma as well as fractures could be recorded for the cranium, while skeletal elements of the upper and lower limb as well as the pectoral and, in one case (Skel. PH 244), the pelvic girdle, are affected by fractures as well as sharp-force injuries (Fig. 6.24).

Weapon-related sharp-force trauma will be discussed in more detail in Chapter 6.3. It is noteworthy that six males out of the observable sample in Pleidelsheim (i.e. 9.7% of males) show injuries related to sharp-force trauma, three of them (Skeletons PH 103, PH 229 and PH 244) exhibiting peri-mortem wounds. One individual had been treated by trepanation, after receiving a very probably life-threatening injury to the right parietal (Fig. 6.25). Technically, the YMA male, who was eventually buried in a chamber grave with weaponry (a lance was found in the disturbed burial), died in the course of this medical intervention, which may have failed due to bleeding from the sagittal sinus, which was damaged by the injury or the intervention. It is very likely that the sword wound sustained beforehand would have been fatal. As there is no evidence for healing, this wound can be classified as a peri-mortem injury.

Fig. 6.25: Skel. PH 229. Trepanation attempt over a sharp-force trauma lesion.

Three males from the Pleidelsheim cemetery sustained fractures of the clavicular midshaft (Fig. 6.24), a fracture type commonly described for medieval populations (Roberts and Manchester 2005: 77) and caused by either direct impact on the bone, or a strong upward and backward force, for instance by landing on outstretched upper limbs or by a fall from a horse (Dandy and Edwards 2009: 188).

Fractures of the metatarsals are present in two males (Skel. PH 116, MTA, and Skel. PH 245, YMA) and could be fatigue fractures, as especially the 2nd metatarsals are prone to this type of injury and are associated with prolonged stress on the feet, e.g. by long marches (Dandy and Edwards 2009: 100).

b) Neresheim

At Neresheim, the ratio of trauma frequencies is 15.8% in males to 12.3 % in females (Table 6.46); there is no significant difference in the prevalence of trauma between males and females (χ^2 = .248, df = 1, N = 103, p = .619).

Table 6.46: Neresheim - Prevalence of trauma by age and sex

Age category	skeletal trauma					
	M		F		Total	
	A/O	%	A/O	%	A/O	%
AD	-	-	0/1	0.0	0/1	0.0
YA	1/4	25.0	0/6	0.0	1/10	10.0
YMA	0/5	0.0	2/15	13.3	2/20	10.0
OMA	2/11	18.2	2/22	9.1	4/33	12.1
MTA	2/13	15.4	2/14	14.3	4/27	14.8
OA	1/5	20.0	2/7	28.6	3/12	25.0
Total	6/38	15.8	8/65	12.3	14/103	13.6

A = affected, O = observed

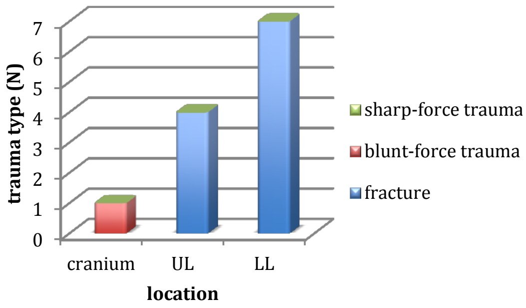


Fig. 6.26: Neresheim - Distribution of trauma types (n˚ of cases)

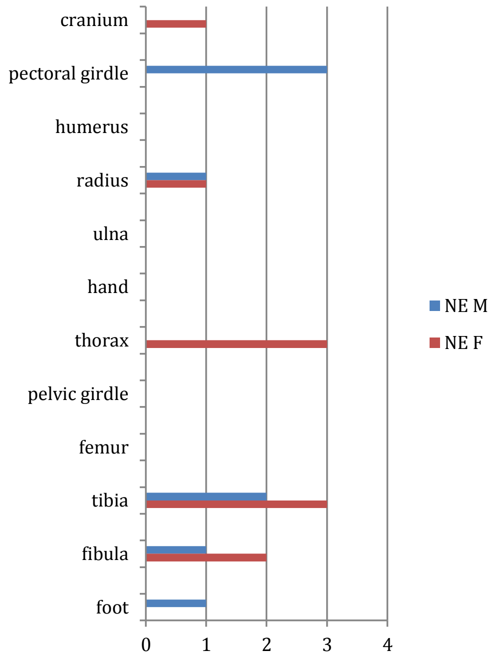


Fig. 6.27: Neresheim - Distribution of trauma (n˚ of cases) by element

No peri-mortem or weapon-related (sharp-force) trauma was observed, but healed blunt-force trauma of the cranium could be recorded (Fig. 6.26) in one female (Skel. NE 66, MTA; App. 6, Table 8). Lower limb fractures most frequently involve the tibia, in both males and females. In the upper limb, a Colles' fracture, likely to be caused by a fall on the outstretched upper limb, can be described in two cases for both sexes (App. 6, Table 8).

Fractures of the clavicle are of different character than those at Pleidelsheim: in the case of a MTA male (Skel. NE 97), a bilateral fracture close to the sternal end of the clavicles could be observed; in another case, that of an OMA male (Skel. NE 80), the individual sustained a fracture to the acromial metaphysis of the right clavicle.

As opposed to the findings for Pleidelsheim, three cases of broken ribs were observed among the female skeletons (Fig. 6.27), probably - given the somewhat younger age of two of the individuals (36 - 45 years) - due to violent or accidental trauma, such as a fall or compression of the chest rather than a severe cough, as it has been described more commonly for elderly individuals (Dandy and Edwards 2009: 168f.).

c) Inter-population comparison

Comparing the traumatic injuries at Pleidelsheim and Neresheim, we find a statistically significant difference in the prevalence of trauma between females (χ^2 = 4.389, df = 1, N = 135, p = .049*), with females at Neresheim showing evidence of significantly higher prevalence rates than those at Pleidelsheim (Table 6.47; Fig. 6.28).

Table 6.47: Comparison of trauma rates in Pleidelsheim and Neresheim

Trauma	M PH - NE	F PH - NE	all PH - NE
%	27.4 * 15.8	2.9 * 12.3	14.4 * 13.6
χ2	1.799	4.389	0.031
p	.180	.049*	.861

*significance at p<.05 level; **significance at p<.01 level

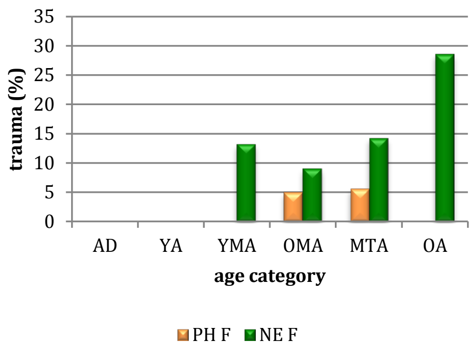


Fig. 6.28: Trauma rates in the female samples of Pleidelsheim and Neresheim

Males in Pleidelsheim show a tendency for comparatively higher trauma prevalence, but to no significant percentage (Table 6.47).

A note on the occurrence of os acromiale

Characterized by the non-fusion of the acromial process of the scapular spine (Liberson 1937), the aetiology of *os acromiale* is still unclear. Genetic predisposition may be a cause, mechanical stress to the rotator cuff muscles during growth may prevent the epiphyseal fusion, or both in combination (Miles 1994 ; Case *et al.* 2006). Given its potential as an activity-related marker (Knüsel 2000a ; Stirland 2005), the occurrence of this trait among the populations under study according to age and sex is listed in Table 6.48.

Table 6.48: Os acromiale - distribution by site, age and sex

Os acromiale		N	Age Category AD	YA	YMA	OMA	MTA	OA
Pleidelsheim	**M**	**26**	1	-	1	2	-	1
	F	**21**	-	-	-	-	-	-
Neresheim	**M**	**16**	-	1	-	1	-	1
	F	**29**	-	-	1	(1)	-	-

In Pleidelsheim, five cases of *os acromiale* (19.2%) were observed, three of which occurred on the right (Fig. 6.29), two on the left scapula, and in no case bilaterally, all of them in males. One OA male exhibited a medial epicondylar avulsion fracture of his left humerus, in addition to an *os acromiale* in the left shoulder.

In Neresheim, three males (18.8%) showed *os acromiale* in the right scapula. However, in this sample, also two females (6.9%) exhibited this condition - an YMA female in her left shoulder, and an OMA female bilaterally.

Fig. 6.29: *Os acromiale*, right scapula, Skel. PH 244

In conclusion, despite the relatively small number of observable cases of trauma in the skeletal remains of the populations under study, we are presented with a differential pattern of antemortem and peri-mortem injuries that might be indicative of general differences in lifeways and environment between the two populations.

The types and distributions of injuries point not only to differences based on sex, within and between Pleidelsheim and Neresheim, but to differing modes of sustaining these injuries, which may have very much to do with lifestyle and interpersonal relations, as well as environmental conditions. Especially the relatively high prevalence of weapon-related trauma in Pleidelsheim will be of further interest to the reconstruction of potential societal differences by means of combined skeletal and archaeological analysis.

6.1.2.7 Other pathological changes

An account of additional observations of pathological changes in the skeletal remains from individuals from Pleidelsheim and Neresheim can be found in App. 6, Table 9 (Pleidelsheim) and Table 10 (Neresheim). Several cases of cranial (button) osteomata, nodular in shape and composed of hard, dense bone (Aufderheide and Rodriguez-Martín 1998) were recorded: eight individuals in Pleidelsheim showed this benign form of neoplasm, among them one female, and only one male from Neresheim (App. 6, Tables 9 and 10). Since this form of neoplasm often remains unnoticed during life, it is not surprising that no special burial treatment was recorded for the affected individuals.

Regarding defects due to disruptions in circulation, only one definite case of osteochondritis dissecans could be observed, notably bilaterally in the distal humeri in an YMA female from Neresheim (Fig. 6.30).

Fig. 6.30: Skel. NE 59, Osteochondritis dissecans (bilaterally)

This separation of a small fragment of bone from the articular joint surface, which can either reattach (such as in the left elbow joint of Skel. NE 59, Fig. 6.30) or becomes detached, has multiple aetiologies but is most commonly described as a micro-traumatic lesion due to defective blood flow as a response to repetitive stress (Knüsel 2000a ; Ortner 2003). It may or may not have been noticeable during life but, if so, the woman many have suffered from pain or instability of the joints.

Finally, there is one observed case with indicators of healed childhood rickets in Pleidelsheim (Skel. PH 259, m, OMA), which entailed some arthritic changes to the thorax of the individual, but did not seem to show any influence on his funerary treatment (coffin burial, with five grave inclusions, including seax and arrows). Another case worthy of note is that of an old adult male with Paget's disease from Pleidelsheim (Skel. OH 158). While only fragments of the cranium are preserved, this individual, comparatively tall in stature (178.4 cm ± 3.37), exhibits not only the typical clinical signs of *osteitis deformans*, i.e. excessive and abnormal bone remodelling (Ortner 2003 ; Brickley and Ives 2008), of long bones, but also relatively diffuse DJD in the form of OA throughout the skeleton (detailed description in App. 6, Table 5), well-developed muscle attachments in the upper limbs (humeri), as well as lytic lesions of the bases of metatarsals III and IV that may be indicative of gout (Ortner 2003). Although the grave of this man, probably a simple burial, remained intact, no grave goods were found with him.

Changes of health patterns from the 5th to 7th century

A breakdown of the prevalence of pathological changes for males and females at Pleidelsheim and Neresheim by period (5th - 7th c. AD) can be found in App. 6, Table 11 (Pleidelsheim) and Table 12 (Neresheim).

An examination of patterns of disease and disability by period resulted in inconclusive trends due to very low numbers of individuals observable for any given condition. The numbers would suggest a downward trend for all groups of pathological conditions in Pleidelsheim towards the 7th c. AD, while in Neresheim, the prevalences would seem to remain consistent, apart from a slight dip during the 6th century. Statistical corroboration of these trends is prevented by small sample sizes.

6.1.3 Relationships between skeletal variables

a) Pleidelsheim

The pathological profile of the skeletal sample from Pleidelsheim (Table 6.49) summarizes antecedent results, including highly significant outcomes regarding the prevalence of a condition within and between cemetery samples.

Table 6.49: Pleidelsheim - Pathological profile of the skeletal series

Lesion	Males		Females		Total	
	A/O	%	A/O	%	A/O	%
			skeletal pathology			
tibial periostitis	12/64	18.8	8/76	10.5	20/140	14.3
maxillary sinusitis	5/64	7.8	7/76	9.2	12/140	8.6
trauma	17/62	27.5	2/70	2.9[4*]	19/132	14.4[1**]
DJD, extra-vertebral	50/63	79.4[3**]	49/77	63.6[3**]	99/140	70.7[1*,3**]
OA*	5/62	8.1	2/77	2.6	7/139	5.0
spondylosis	28/54	51.9	32/58	55.2	60/112	53.6
spondyloarthrosis	16/52	30.8	10/54	18.5	26/106	24.5[1**]
Schmorl's nodes	31/45	68.9	23/47	48.9[3*]	54/92	58.7[1*]
Cribra orbitalia	20/47	42.6	16/53	30.2[4*]	36/100	36.0[4*]
Button osteoma	7/60	11.7	1/69	1.4	8/129	6.2
			dental pathology			
enamel hypoplasia	17/45	37.8[4**]	27/56	48.2[4*]	44/101	43.6[4**]
caries	31/61	50.8	36/74	48.6	67/135	49.6
periodontal disease	8/61	13.1	12/74	16.2[*3]	20/135	14.8[*3]
peri-apical disease	9/61	14.8	11/74	14.9	20/135	14.8
AMTL	18/61	29.5[*4]	10/74	13.5[**4]	28/135	20.7[*1, **4]

A = affected, O = observed
* as evidenced by eburnation
[1]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01) **in M than in F**.
[2]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01) **in F than in M**.
[3]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01 **in Pleidelsheim**.
[4]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01) **in Neresheim**.

In addition to the trends and significant results obtained for the two sexes as well as cemeteries, an analysis of the relationships between the skeletal variables studied proves further elucidating (Table 6.50 and Table 6.51)[99]. Considering the males from Pleidelsheim (Table 5.2.54), we do find a number of correlations among the skeletal conditions, some of which are predictable, others providing interesting clues.

There is a predictable, positive association between spondylosis and spondyloarthrosis, as well as between the latter and the occurrence of OA in the body. If an individual is susceptible to DJD, due to predisposition, age, or heightened levels of physical stress, it is likely that, with increasing age and stress, the probability for developing arthritic changes increases.

[99] These correlations are based on the occurrence of pathological changes to skeletal material from intact burials only, in order to clarify important relationships and to aid a later collation of findings with those resulting from the comparison with elements from funerary contexts.

Table 6.50: Relationships of skeletal variables - Pleidelsheim Males (N = 57, intact burials)

	Stature[3]	Cribra orbitalia[1]	Enamel hypoplasia[1]	Schmorl's nodes[1]	Spondylosis[1]	Spondyloarthrosis[1]	OA[1]	DJD[1]	Trauma[1]	Weapon-related trauma[1]	Tibial periostitis[1]
Stature[3]	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cribra orbitalia[1]	NS	-	NS	NS	NS	NS	NS	NS	NS	NS	NS
Enamel hypoplasia[1]	NS	NS	-	NS	NS	NS	.037*	NS	NS	NS	.049*
Schmorl's nodes[1]	NS	NS	NS	-	NS	NS	NS	NS	NS	NS	NS
Spondylosis[1]	NS	NS	NS	NS	-	.005**	NS	NS	NS	NS	.031*
Spondyloarthrosis[1]	NS	NS	NS	NS	.005**	-	.005**	NS	NS	NS	NS
OA[1]	NS	NS	.037*	NS	NS	.005**	-	NS	NS	NS	NS
DJD[1]	NS	NS	NS	NS	NS	NS	NS	-	NS	NS	NS
Trauma[1]	NS	NS	NS	NS	NS	NS	NS	NS	-	.001**	NS
Weapon-related trauma[1]	NS	NS	NS	NS	NS	NS	NS	NS	.001**	-	NS
Tibial periostitis[1]	NS	NS	.049*	NS	.342*	NS	NS	NS	NS	NS	-

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Notes on significant relationships:

Relationship	Significance	Comments
*enamel hypoplasia * OA*	ρ = .354, N = 35	positive correlation
*enamel hypoplasia * tibial periostitis*	ρ = -.375, N = 28	inverse relationship
*spondylosis * spondyloarthrosis*	ρ = .451, N = 37	positive correlation
*spondylosis * tibial periostitis*	ρ = .342, N = 40	positive correlation
spondyloarthrosis OA*	ρ = .449, N = 38	positive correlation
*trauma * weapon-related trauma*	ρ = .492, N = 46	positive correlation

Table 6.51: Relationships of skeletal variables - Pleidelsheim Females (N = 60, intact burials)

	Stature[3]	Cribra orbitalia[1]	Enamel hypoplasia[1]	Schmorl's nodes[1]	Spondylosis[1]	Spondyloarthrosis[1]	OA[1]	DJD[1]	Trauma[1]	Weapon-related trauma[1]	Tibial periostitis[1]
Stature[3]	-	.012*	NS	NS	NS	NS	NS	NS	NS	ND	NS
Cribra orbitalia[1]	.012*	-	NS	NS	NS	NS	NS	NS	NS	ND	NS
Enamel hypoplasia[1]	NS	NS	-	NS	.043*	NS	NS	NS	NS	ND	NS
Schmorl's nodes[1]	NS	NS	NS	-	NS	NS	NS	NS	NS	ND	NS
Spondylosis[1]	NS	NS	.043*	NS	-	.038*	NS	NS	NS	ND	NS
Spondyloarthrosis[1]	NS	NS	NS	NS	.038*	-	NS	NS	NS	ND	NS
OA[1]	NS	NS	NS	NS	NS	NS	-	NS	NS	ND	NS
DJD[1]	NS	NS	NS	NS	NS	NS		-	NS	ND	NS
Trauma[1]	ND	NS	ND	ND	ND	ND	NS	NS	-	ND	NS
Weapon-related trauma[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Tibial periostitis[1]	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	-

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Notes on significant relationships:

Relationship	**Significance**	**Comments**
*stature * cribra orbitalia*	ρ = -.454, N = 30	inverse relationship
*spondylosis * enamel hypoplasia*	ρ = -.378, N = 29	inverse relationship
*spondylosis * spondyloarthrosis*	ρ = .333, N = 39	positive correlation

More interesting is the finding that at Pleidelsheim, males with increased rates of DEH, an indicator of childhood stress, also seem more disposed to severe DJD in adulthood (Table 6.50). This indicates that the severe form of joint degeneration during adulthood is coupled with inferior conditions during growth, i.e. either these individuals were biologically prone to more severe forms of degenerative disease, or were exposed to higher amounts of physical stress during adulthood than others. The relationship between DEH and tibial periostitis is, however, of inverse character, the reduced frequency of this childhood stress indicator comes with an increase in an 'adult' stress marker. While this in itself does not permit the inference that the occurrence of tibial periostitis may have been related to increased levels of activity, or even may be an activity-related change to the bone, its positive correlation with spondylosis prevalence does suggest this relationship (Table 6.50).

The data indicate that for males in Pleidelsheim, the occurrence of spondylosis and periostitis can be suggestive of those pathological findings being primarily activity-related changes, probably in their combination attached to men who grew up in relatively favourable conditions. The positive correlation between trauma and weapon-related trauma (Table 6.50), as such not surprising given the relatively high number of weapon-related trauma in Pleidelsheim's male population, emphasizes this implication.

The findings for females in Pleidelsheim are unambiguous (Table 6.51): We can observe an inverse relationship between stature and CO as well as between spondylosis and DEH. The taller a woman was, the less likely she would exhibit an indicator of childhood stress, which points to those having grown up in more favourable conditions also attaining increased body height. Yet, it also suggests that women of taller stature have benefited from a better status in society throughout childhood. Whether any such correlation is maintained during adulthood remains to be explored by investigating the funerary context (below).

The inverse correlation between another indicator of childhood stress, DEH, and vertebral DJD (Table 6.51), is interesting, as it suggests a similarity with the male population. For reasons yet unresolved, women who grew up in supposedly favourable conditions show an increased frequency of spondylosis (which is positively correlated with spondyloarthrosis, Table 6.51), indicating relatively high levels of physical stress for those individuals[100].

[100] Already younger women (YMA) demonstrated increased degeneration in the Pleidelsheim population (cf. Chapter 6.1.2.3).

b) Neresheim

Table 6.52 presents the pathological profile for the skeletal population of Neresheim and summarizes the significant findings regarding inter- and intra-population differences.

Table 6.52: Neresheim - Pathological profile of the skeletal series

Lesion	Males		Females		Total	
	A/O	%	A/O	%	A/O	%
			skeletal pathology			
tibial periostitis	8/41	19.5	7/79	8.9	15/120	12.5
maxillary sinusitis	4/41	9.8	10/77	13.0	14/120	11.7
trauma	6/38	15.8	8/65	12.3[4*]	14/103	13.6
DJD, extra-vertebral	20/39	51.3[3**]	20/67	29.9[3**]	41/106	38.7[1*,3**]
OA*	3/39	7.7	4/67	6.0	7/106	6.6
spondylosis	17/31	54.8	22/42	52.4	39/73	53.4
spondyloarthrosis	11/30	36.7	9/43	20.9	20/73	27.4
Schmorl's nodes	19/27	70.4	9/35	25.7[3*]	28/62	45.2[1**]
Cribra orbitalia	16/26	61.5	27/54	50.0[4*]	43/80	53.8[4*]
Button osteoma	1/36	2.8	1/64	1.6	2/100	2.0
			dental pathology			
enamel hypoplasia	19/26	73.1[4**]	34/49	69.4[4*]	53/75	70.7[4**]
caries	14/36	53.8	26/69	37.7	40/105	38.1
periodontal disease	4/36	11.1	3/69	4.3[*3]	7/105	6.7[*3]
peri-apical disease	6/36	16.7	6/69	8.7	12/105	11.4
AMTL	18/36	50.0[*4]	36/69	52.2[**4]	54/105	51.4[**4]

A = affected, O = observed
*as evidenced by eburnation
[1]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01) **in M than in F**.
[2]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01) **in F than in M**.
[3]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01 **in Pleidelsheim**.
[4]The prevalence of the condition is *significantly higher (p < .05) / **significantly higher (p < .01) **in Neresheim**.

Analysis for potential relationships between skeletal variables revealed a number of correlations that accentuate the differential patterns of physical characteristics found in this population (Table 6.53 and Table 6.54), compared to Pleidelsheim.

Males from Neresheim show an inverse relationship between stature and the prevalence of Schmorl's nodes (SN; Table 6.53). The taller a man was, the less susceptible he was to this form of degeneration of the vertebral column. This is interesting considering the earlier observation that males buried in chamber graves in Neresheim were taller on average than those buried in coffins, who, in contrast, were significantly taller than those males interred in ‘simple’ graves (cf. Chapter 6.1.1). This points to males of taller stature possibly having been exposed to less physical stress during adulthood, unless, considering the osteological paradox (Wood *et al.* 1992), they died before conditions related to physical stress could accumulate.

Table 6.53: Relationships of skeletal variables - Neresheim Males (N = 17, intact burials)

	Stature[3]	**Cribra orbitalia[1]**	**Enamel hypoplasia[1]**	**Schmorl's nodes[1]**	**Spondylosis[1]**	**Spondyloarthrosis[1]**	**OA[1]**	**DJD[1]**	**Trauma[1]**	**Weapon-related trauma[1]**	**Tibial periostitis[1]**
Stature[3]	-	NS	NS	.008**	NS	NS	NS	NS	NS	ND	NS
Cribra orbitalia[1]	NS	-	ND	NS	NS	NS	NS	NS	NS	ND	NS
Enamel hypoplasia[1]	NS	ND	-	NS	NS	NS	NS	NS	NS	ND	NS
Schmorl's nodes[1]	.008**	NS	NS	-	NS	NS	NS	NS	NS	ND	NS
Spondylosis[1]	NS	NS	NS	NS	-	NS	NS	NS	NS	ND	NS
Spondyloarthrosis[1]	NS	NS	NS	NS	NS	-	NS	NS	NS	ND	NS
OA[1]	NS	NS	NS	NS	NS	NS	-	.045*	NS	ND	.012*
DJD[1]	NS	NS	NS	NS	NS	NS	.045*	-	NS	ND	.045*
Trauma[1]	NS	NS	NS	NS	NS	NS	NS	NS	-	ND	NS
Weapon-related trauma[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	ND
Tibial periostitis[1]	NS	NS	NS	NS	NS	NS	.012*	.045*	NS	ND	-

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Notes on significant relationships:

Relationship	**Significance**	**Comments**
*stature * Schmorl's nodes*	ρ = -.845, N = 8	inverse relationship
*DJD * OA*	ρ = .491, N = 17	positive correlation
*tibial periostitis * DJD*	ρ = .595, N = 17	positive correlation
*tibial periostitis * OA*	ρ = .491, N = 17	positive correlation

Table 6.54: Relationships of skeletal variables - Neresheim Females (N = 42, intact burials)

	Stature[3]	**Cribra orbitalia[1]**	**Enamel hypoplasia[1]**	**Schmorl's nodes[1]**	**Spondylosis[1]**	**Spondyloarthrosis[1]**	**OA[1]**	**DJD[1]**	**Trauma[1]**	**Weapon-related trauma[1]**	**Tibial periostitis[1]**
Stature[3]	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	NS
Cribra orbitalia[1]	NS	NS	NS	NS	NS	NS	NS	.011*	NS	ND	NS
Enamel hypoplasia[1]	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	NS
Schmorl's nodes[1]	NS	NS	NS	NS	NS	NS	NS	NS	.025*	ND	.034*
Spondylosis[1]	NS	NS	NS	NS	NS	.003**	NS	.000**	NS	ND	NS
Spondyloarthrosis[1]	NS	NS	NS	NS	.003**	NS	NS	NS	NS	ND	NS
OA[1]	NS	NS	NS	NS	NS	NS	NS	.010**	NS	ND	NS
DJD[1]	NS	.011*	NS	NS	.000**	NS	.010**	NS	NS	ND	NS
Trauma[1]	NS	NS	NS	.025*	NS	NS	NS	NS	NS	ND	NS
Weapon-related trauma[1]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tibial periostitis[1]	NS	NS	NS	.034*	NS	NS	NS	NS	NS	ND	NS

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Notes on significant relationships:

Relationship	**Significance**	**Comments**
*Schmorl's nodes * trauma*	ρ = .467, N = 23	positive correlation
*Schmorl's nodes * tibial periostitis*	ρ = .444, N = 23	positive correlation
*spondylosis * spondyloarthrosis*	ρ = .537, N = 24	positive correlation
*spondylosis * DJD*	ρ = .678, N = 25	positive correlation
*DJD * cribra orbitalia*	ρ = .448, N = 31	positive correlation
*DJD * OA*	ρ = .392, N = 42	positive correlation

The detection of a positive correlation between extra-vertebral DJD, OA and tibial periostitis (Table 6.53) suggests that males in Neresheim, although exhibiting on average lower rates for DJD than males in Pleidelsheim (Table 6.49; Table 6.52), were subjected to high levels of physical activity. This is indicated by joint degeneration and tibial periosteal reactions, which in this case suggests that tibial periostitis can be regarded as activity-related.

Analysis of skeletal variables and their relationships in the female sample (Table 6.52; Table 6.54) demonstrates that, in fact, this holds true for *all* individuals in the Neresheim population. We find a positive correlation in the females from Neresheim between vertebral DJD and arthritic changes, coupled with extra-vertebral DJD and OA (Table 6.54). Schmorl's nodes, albeit in males significantly more prevalent, appear in a significant relationship with tibial periostitis and with trauma rates, which completes the picture of females having been subjected to high levels of physical stress and activity, given the earlier observation that consistent frequencies in SN during life may have been activity-related rather than solely age-related (cf. Chapter 6.1.2.3). The correlation between SN and trauma is furthermore interesting regarding the relatively high number of lower limb fractures occurring among the females of Neresheim (cf. Chapter 6.1.2.6).

Finally, the data reveal a positive correlation between CO, i.e. a childhood stress indicator, and DJD, which suggests that those females who might have grown up in less favourable conditions were also subjected to a physically harder life during adulthood, or, as mentioned before, they might have been more prone to developing degenerative conditions.

6.2 Skeletal and funerary variables: Indications of social variability?

A comparison of the skeletal variables with archaeological elements, i.e. grave goods and burial types, provides continuing evidence that the two populations are very different and distinct with regard to their possible societal patterns.

6.2.1 Stature and status

In order to investigate whether a possible relationship exists between stature and grave good provision, the burial wealth (i.e. number of GG as well as number of AT) in the intact burials from Pleidelsheim and Neresheim was assessed and correlated with the calculated stature estimates. Male burials were furthermore differentiated into those buried with weapons and those buried without, as weapons form a significant part of most men’s grave good assemblages.

Male stature and burial endowment

Table 6.55 lists the number of GG found in male burials in Pleidelsheim (PH) and Neresheim (NE) and a collation of corresponding numbers of cases found with these amounts of GG, as well as the respective stature means.

Table 6.55: Male stature and grave goods

n˚ of GG	PH cases	stature*	NE cases	stature*
0	2	175.5	2	176.6
1	3	174.7	2	171.5
2	1	177.9	3	178.3
3	1	159.1	0	-
4	3	176.7	0	-
5	5	170.7	2	173.8
6	4	177.2	0	-
7	2	172.4	0	-
8	2	172.5	0	-
9	1	177.9	0	-
10	2	170.8	0	-
11	1	173.4	1	168.6
12	3	177.2	0	-
13	2	180.1	0	-
14	0	-	0	-
15+	7	173.4	0	-
with weapons	29	174.3	4	174.0
without weapons	11	173.6	6	175.2

*average body height in cm

In Pleidelsheim, 40 intact burials could be analyzed, in Neresheim, only ten could be. While at Pleidelsheim, more than 15 GG could be found in a burial, at Neresheim, the maximum number was eleven. However, in both cases it quickly becomes apparent that there is no significant change in average stature with increasing numbers of GG, which is confirmed by a non-significant correlation between the two factors (Pleidelsheim: $\rho = .062$, $p = .702$, Neresheim: $\rho = .266$, $p = .457$). Also, no significant difference could be found between the body heights of males buried with weapons and those buried without (Pleidelsheim: $p = .777$, Neresheim: $p = .660$).

Table 6.56: Male stature and artefact types

n˚ of AT	PH cases	stature*	NE cases	stature*
0	4	171.6	1	172.8
1	3	176.2	2	178.0
2 - 4	10	173.2	6	173.9
5 - 7	11	174.0	1	174.9
8 - 10	8	173.2	0	-
11+	5	177.1	0	-
with weapons	29	174.3	4	174.0
without weapons	11	173.6	6	175.2

*average body height in cm

Analysis of a relationship between the number *and* variety of artefacts, measured by the number of AT (Table 6.56), produced the same results: no significant correlation was found between the number of AT and stature (Pleidelsheim: $\rho = .064$, $p = .698$, Neresheim: $\rho = .519$, $p = .125$), and no significant difference either between those males buried with and those buried without weapons. However, in Pleidelsheim, there seems to be a slight trend of males in intact burials with more than 11 AT to be taller, on average, than those with less AT.

For the males in both populations, it therefore cannot be concluded that those individuals buried with a greater number and / or variety of GG, or with weaponry, were taller than their counterparts within the same population. A slight tendency towards higher numbers of AT and body height is detectable in male burials at Pleidelsheim, which could point to a correlation between stature and status. It has been suggested by Härke (1992), as well as Straub (1956) and Czarnetzki *et al.* (1983) that those individuals of 'higher rank' (NB: defined by now out-dated archaeological determinants of material culture) were generally taller than those of lower social standing ('nobles' - 'free' - 'unfree').

Given these researchers' contention that 'high rank' was indicated by burial with weapons, and the previously demonstrated association between burial wealth and weaponry in burials from Pleidelsheim (cf. Chapter 5.3.2), it remains to be seen whether a more detailed examination of weapon types and stature reveals a stronger associations with social standing.

Female stature and burial endowment

At first glance, the assessment of female burial wealth in terms of GG and its correlation with stature displays exactly same averages (158.1 cm) for women at Pleidelsheim buried without any GG as for those buried with 15 GG and more (Table 6.57). The same applies to the female sample from Neresheim (162.6 cm for 0 and 15+ GG).

Table 6.57: Female stature and grave goods

n° of GG	PH cases	stature*	NE cases	stature*
0	6	158.1	9	162.6
1	4	160.4	7	163.3
2	4	164.9	1	155.4
3	8	160.8	2	155.4
4	6	158.1	4	164.9
5	2	155.0	1	160.6
6	2	162.4	1	165.2
7	3	166.8	2	166.8
8	2	169.6	0	-
9	2	164.7	1	161.1
10	2	165.5	0	-
11	0	-	0	-
12	0	-	0	-
13	1	156.6	0	-
14	3	168.1	0	-
15+	6	158.1	9	162.6
without GG	6	158.1	9	162.6
with GG	39	162.4	19	163.4

*average body height in cm

However, a closer look at the mean stature estimates with increasing numbers of GG overall reveals a corresponding increase in mean body height in the female sample from Pleidelsheim, and despite a drop when reaching 15+ GG, this correlation of stature and GG provision is statistically significant (ρ = .309 p = .039*; Fig. 6.31), i.e. the taller a woman in Pleidelsheim, the more GG could be expected in her burial.

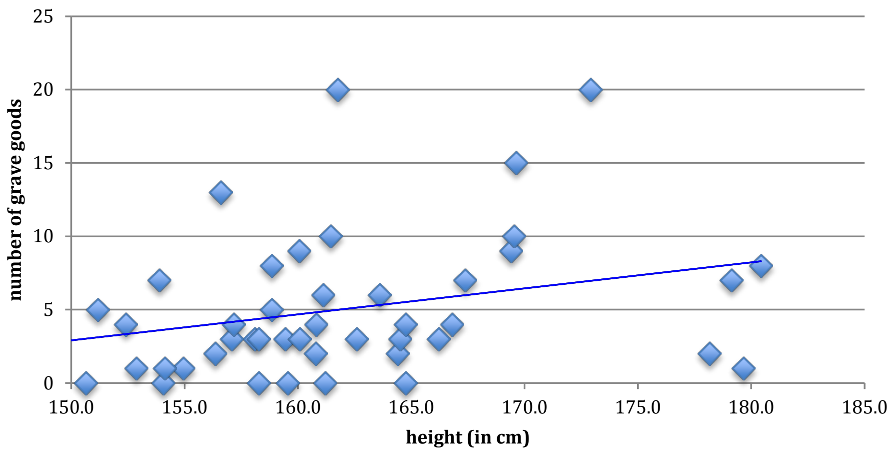


Fig. 6.31: Pleidelsheim - Female stature and grave goods

In Neresheim, no such correlation could be detected, and there is also no statistically significant difference when comparing those buried with and without GG in general, for both populations (Pleidelsheim: p = .218, Neresheim: p = .753).

This finding for females from Pleidelsheim is elucidated when considering not the number of GG, but the entire burial wealth, i.e. the artefact distribution, the number of AT, in connection with stature (Table 6.58):

Table 6.58: Female stature and artefact types

n° of AT	PH cases	stature*	NE cases	stature*
0	6	158.1	11	163.4
1	4	160.4	4	162.7
2 - 4	18	161.0	10	162.8
5 - 7	10	163.2	2	163.2
8 - 10	3	166.3	1	164.5
11+	4	165.2	0	-

*average body height in cm

While in Neresheim, a slight trend is noticeable for an increase in body height that entails an increase in burial wealth (despite only one case that could be observed for the 8-10 AT category), the steady increase in average stature, coupled with the augmentation of burial wealth and variety, for females from Pleidelsheim is marked. It does not produce a statistically significant difference, but at least a very strong tendency ($\rho = .309$ $p = .055$). The combination of this with the finding that the taller the woman, the fewer childhood stress indicators she exhibits (cf. Chapter 6.1.3) strongly indicates that stature serves as an indicator of status in the female population in Pleidelsheim.

6.2.2 Palaeopathology and funerary variables

While in the first part of this chapter the prevalence of a pathological condition within and between the populations of Pleidelsheim and Neresheim was analyzed and discussed, with a view to elucidating variations between the sexes and populations in general, the following analyses focus on four main "burial groups", defined by the presence of grave goods and weaponry:

- individuals buried with GG;
- of those, individuals buried with GG but without weaponry;

- individuals buried without any GG;
- individuals buried with weapons.

The latter group will be examined in detail in Chapter 6.3, while for the remaining three, the following questions are investigated:

i) Do individuals buried with GG show a differing prevalence of a particular condition to those individuals buried without any GG?

ii) Can we observe a difference in the prevalence of a particular condition when comparing individuals from the above groups to those individuals buried with GG, but without weaponry?

iii) Is there a difference in the prevalence of a particular condition between the individuals buried in any of the three different types of burial ('simple' grave, coffin, chamber grave)?

The aspect of analysing the subgroup "GG no weaponry" arises from the consideration of weaponry as a potential status symbol. If significant differences emerge in this comparison, it supports the earlier indication of weaponry forming a meaningful (status-linked) symbol in death. Moreover, it aids the distinction of potential discrete groups within the cemetery populations, sharing archaeological and biological characteristics.

For this analysis, only intact burials were considered. Tests were conducted for males and females as well as for the total population; no division into age categories was used, as the sample sizes would have become too small to allow for any statistical treatment. Since these analyses serve to facilitate the identification of potential status-related differences within each population, the results of the Pleidelsheim sample will be discussed first, followed by those of the Neresheim sample.

6.2.2.1 Pleidelsheim

Table 6.59 provides a comparative overview of the frequencies of each skeletal variable under study as occurring in every examined burial group (GG - individuals buried with GG; no GG - individuals buried without any GG; GG NW - individuals buried with GG but without weaponry), as well as the results of tests for statistical significance. Detailed records of the number of cases presenting a particular condition or appearing as unaffected can be found in App. 6, Tables 13 - 27.

Table 6.59: Pleidelsheim - Overview of condition frequencies (%) by sex and subgroup and significant outcomes

Lesion	Males				Females			
	GG	no GG	GG NW	p - value	GG	no GG	GG NW	p - value
skeletal pathology								
tibial periostitis (% affected)	11.9	33.3	22.2	NS	4.2	25.0	4.3	NS#
maxillary sinusitis (% affected)	7.1	33.3	0.0	NS#	4.2	12.5	4.3	NS
trauma (% affected)	31.7	0.0	0.0	NS#	2.2	0.0	2.3	NS
DJD, extra-vertebral (% affected)	85.7	100.0	80.0	NS	65.3	70.0	66.7	NS
OA[a)] (% affected)	70.3	33.3	0.0	NS	4.1	0.0	4.2	NS
spondylosis (% affected)	52.8	60.0	50.0	NS	64.9	50.0	[64.9]	NS
spondyloarthrosis (% affected)	35.3	50.0	42.9	NS	21.2	66.7	[21.2]	.048*
Schmorl's nodes (% affected)	69.7	50.0	71.4	NS	48.4	0.0	[48.4]	NS
Cribra orbitalia (% affected)	39.4	60.0	39.1	NS	36.1	40.0	41.7	NS
dental pathology								
enamel hypoplasia (% with > 1 lesion)	43.8	33.3	39.1	NS	59.5	25.0	69.0	NS
caries (% affected)	62.8	0.0	90.9	.012* (GG:N GG) .002** (all groups)	48.9	42.9	50.0	NS
peri-apical disease (% affected)	18.6	0.0	18.2	NS	12.8	14.3	13.0	NS
periodontal disease (% affected)	11.6	20.0	0.0	NS	19.1	0.0	19.6	NS
AMTL (% affected)	27.9	40.0	27.3	NS	12.8	14.3	13.0	NS

[a)] as evidenced by eburnation; # strong tendency; * significance at p < .05 level, **significance at p < .01 level

Indicators of childhood stress

Among the 79 intact burials observable for the occurrence of CO, no significant difference regarding the prevalence of this childhood stress indicator was found in the comparison of individuals buried with GG and without (App. 6, Table 13). Only a slight tendency was observable among males buried without GG, who showed a higher frequency of CO than those endowed with GG (60% : 39.4%, Table 6.59). Out of 69 individuals with GG, 69.7 % of all male burials and 66.7 % of all female graves were devoid of items of weaponry. A comparison of all three types of burial accoutrement also resulted in no significant difference in CO rates between the subgroups, and no difference was detectable regarding CO prevalence and the three different burial modes (App. 6, Table 13).

The investigation of DEH rates equally yielded no significant differences among the 76 intact burials observable for this condition (App. 6, Table 14). It is interesting, however, that while those individuals without GG showed a higher prevalence of CO than those buried with GG, it is the opposite regarding DEH, especially in the female sample (DEH frequency F GG: 59.5%, F no GG: 25%, Table 6.59). Of the observed cases, 71.9 % of all male and 78.4% of all female burials provided with GG did not contain weaponry, yet no significant difference in the occurrence of DEH was noticeable. The analysis of individuals buried in different grave types generated the same result (App. 6, Table 14).

Considering the joint manifestation of CO and DEH, 17 cases in Pleidelsheim (M = 12, F = 5, all intact burials) were observable. Only one of them, a male interment, was found without any GG, and three of the males were buried with weaponry. The finding of no significant difference among groups here adds to the conclusion that childhood stress indicators do not reveal any correlation with status in life or death for the Pleidelsheim population.

Indicators of stress: Non-specific infections

Overall, 104 intact burials from Pleidelsheim could be examined for the presence of tibial periostitis (App. 6, Table 15) and maxillary sinusitis (App. 6, Table 16). There is a significant difference in the prevalence of tibial periostitis between those individuals buried with GG and those buried without at Pleidelsheim (χ^2 = 5.538, df = 1, N = 104, p = .04*), with those individuals buried without any GG showing a higher prevalence of the condition (28.6%) than those buried with grave goods (7.8%).

A closer look at males and females separately initially revealed no significant difference when looking at the male burials, although a tendency appeared to be present, with males buried without GG showing 33.3% affected by tibial periostitis, as opposed to 11.9% in those buried with GG and 22.2% in those provided with GG but not with weaponry (21.4% of all male burials; Table 6.59). In females, the trend is even more distinct (individuals buried without GG: 25%, with GG: 4.2%; Table 6.59).

When including those individuals buried with GG yet without weaponry - in this case, 97.9% of all observable female burials -, a significant difference emerges between all three groups (χ^2 = 6.671, df = 2, N = 160, p = .036*), due to the fact that those individuals buried without any grave goods show a much higher frequency of tibial periostitis (28.6%) than the other two groups examined (GG: 7.8%, GG no weaponry: 7.1%; App. 6, Table 15). It is again something that, under more close examination, is expressed much more strongly in the females than in the males (χ^2 = 5.814, df = 2, N = 57, p = .055, FET). Thus, the tendency of having higher rates of tibial periostitis in burials without GG is found among females rather than among males, concurrent with the finding that women in Pleidelsheim seem to have been less prone to accidental trauma (cf. Chapter 6.1.2.6), but also indicating that women buried with GG might have been less susceptible to (non-specific) infectious diseases than those buried without any.

No statistically significant difference in the prevalence of tibial periostitis could be found between individuals, either males or females, buried in coffins, 'simple' graves or chamber graves (App. 6, Table 15). However, it is notable that individuals in chamber burials do not show any tibial periostitis, whereas those buried in coffins show 17% prevalence and those in simple graves 12.9%.

Considering rates of maxillary sinusitis, a strong tendency (χ^2 = 4.299, df = 1, N = 104, p = .073) could be uncovered for those individuals buried without any GG to show a higher prevalence of the condition (21.4%) than those buried with grave goods (5.6%; App. 6, Table 16). This could be traced back to the male sample at closer inspection, with a trend of significantly higher prevalence rates of maxillary sinusitis in those males buried without any GG (33.3%) as opposed to those with GG (7.1%) or with GG, but devoid of weaponry (0.0%, Table 6.59; p = .063, FET).

Overall, we do see the same pattern with this type of non-specific infectious disease as in tibial periostitis: those individuals without any GG seem to have suffered from more pathological changes of this type than those endowed with GG. This may be a reflection of status. However, this finding is not mirrored in the analysis of different grave types, which, again, resulted in no detectable significant difference (App. 6, Table 16). It has to be noted, however, that while in the male population, those buried in chamber graves seem to show no evidence for maxillary sinusitis at all, while in the female population, those buried in chamber graves show the highest prevalence compared to those buried in more simple graves (11.8%, as opposed to 8.3% in coffin burials and 5.3% in simple graves).

Vertebral degenerative joint disease

Forty-nine individuals out of 84 intact observable burials from Pleidelsheim showed the manifestation of spondylosis, but no difference could be identified regarding the prevalence of this type of vertebral DJD among the three burial groups (with 22.2% of all male burials containing GG but no weaponry; App. 6, Table 17; Table 6.59). Only when examining the various grave types, a relatively stronger tendency emerged for higher spondylosis rates to prevail in individuals interred in simple or, primarily, coffin burials, as opposed to those in chamber graves (Fig. 6.32; App. 6, Table 17), for males and females in equal measure.

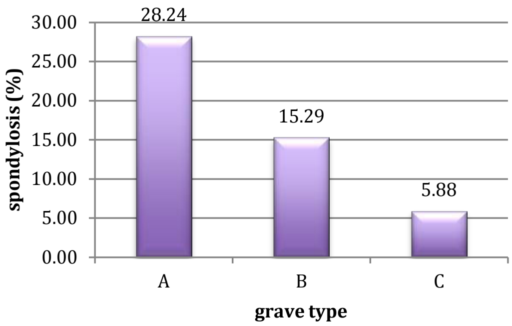


Fig. 6.32: Pleidelsheim - Spondylosis frequencies in different grave types

The skeletal remains of 77 intact burials were observable for spondyloarthrosis (App. 6, Table 18). While for the total population, no significant difference between the three burial groups could be found, individuals buried without GG show a trend for higher prevalence of spondyloarthrosis than those whose burials were provided with GG (Table 6.59). This becomes a significant difference when examining female burials only (p = .042*, FET), with females buried without GG showing a significantly higher prevalence rate of the condition (66.7%) than females buried with GG (21.2%, Table 6.59). Thus, males may have shown a much higher prevalence of spondyloarthrosis *per se* (cf. Chapter 6.1.2.3), but it is in the female sample that meaningful distributions of relative frequency of this vertebral degenerative disease are reflected in the burial mode.

No such statistically significant difference, but a tendency could be discerned when analysing individuals in their particular grave types (App. 6, Table 18), with individuals buried in chamber graves showing the lowest prevalence of the condition (3.7%, as opposed to coffin burials, 16.1%, or simple burials. 6.2%).

Considering the data for spondylolysis, with positive examples from 71 observable intact burials, divided by burial group (with 20% of all male burials devoid of weaponry) as well as by sex, or by grave type, proved far too small to allow for any formal statistical analysis (App. 6, Table 19).

Prevalence rates of Schmorl's nodes (SN) in 69 intact burials could be examined, and 39 individuals showed evidence of the condition (App. 6, Table 20). However, there is no significant difference among the three burial groups, even though females buried without GG seem to show no traces of SN at all, as opposed to those buried with GG (Table 6.59), something that has to be taken with caution, as the sample size for female burials without GG was exceptionally small. It can, however, be noted that generally, and contrary to the results for spondylosis and spondyloarthrosis frequencies that tend to be higher in individuals buried without any GG, individuals from this subgroup show lower frequencies of SN than those buried with GG (Table 6.59).

Although the test for statistical differences of SN rates between the three types of interment turned out to be non-significant, the tendency was very strong (χ^2 = 5.179, df = 2, N = 71, p = .075), for those individuals buried in simple graves to show a reduced prevalence of SN (36.6%) when compared with those buried in either coffins (65.71%) or chamber graves (64.29%). When testing for male and female burials separately, this emerged as a highly significant difference between burial types and rates of SN in case of male burials (p = .003**, FET), with much lower frequency of Schmorl's nodes (27.3%) in those buried in simple graves than those buried in either coffins (85.7%) or chamber graves (80%). No such difference could be found in the female burials.

Altogether, the generally high rates of vertebral DJD for individuals buried in coffins, especially males, may be related to the fact that at Pleidelsheim, most males were buried in coffins (cf. Chapter 5.1.3). It may also be meaningful that these men are also receiving the highest numbers of GG and AT (cf. Chapter 5.2.1). This is particularly interesting, as males buried in chamber graves also have a high prevalence of SN, given all other types of vertebral DJD showing decreased rates in individuals buried in this type of sepulchre. With reference to the occurrence of SN in Pleidelsheim males in general, this might suggest that these men were exposed to comparatively high levels of certain stressful activities that predisposed to SN.

Extra-vertebral degenerative joint disease and osteoarthritis

Of the 101 intact burials observable for the evidence of extra-vertebral DJD and OA, 23.8% of all male and 98% of all female graves containing GG did not include items of weaponry. Altogether, 75 individuals displayed indicators for DJD. Between the different burial groups, no significant difference was found for this condition to preferentially affect one group or the other, neither among males nor females (App. 6, Table 21). For both males and females, individuals without GG show a trend for higher prevalence of DJD than those buried with GG or with GG, but without weaponry (Table 6.59).

Analysing the skeletal remains by grave type, it emerges that there is a statistically significant difference in the prevalence of DJD between individuals buried in coffins, 'simple' graves or chamber graves (χ^2 = 6.934, df = 2, N = 111, p = .031*; Fig. 6.33). This difference becomes highly significant when individuals buried in coffins (A) are compared to those buried in more elaborate chamber graves (C) (χ^2 = 6.497, df = 1, N = 80, p = .01**), i.e. individuals buried in chamber graves show much less prevalence of DJD than those in less lavish graves, yet, interestingly, not compared to the assumingly most 'simple' burial type.

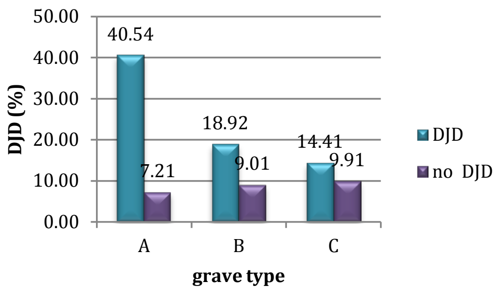


Fig. 6.33: Pleidelsheim - DJD frequencies by grave type

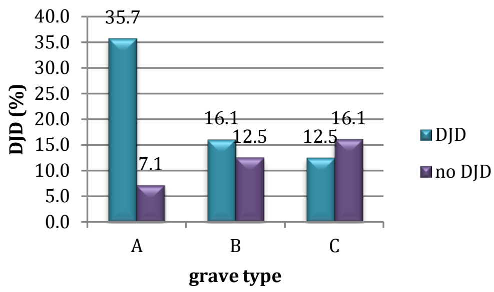


Fig. 6.34: Pleidelsheim - DJD frequencies by grave type, female burials

Examination in more detail reveals that this significant correlation of grave type and DJD only appears in cases of female burials (χ^2 = 7.181, df = 2, N = 56, p = .028*), with a clear prevalence of DJD in coffin burials (Fig. 6.34).

Only six individuals (three males and two females) presented cases of (severe) OA (App. 6, Table 22). While no significant differences among the various burial groups or grave types could be detected for the prevalence of OA, it is noteworthy that, as opposed to less severe DJD, severe OA affected males and females buried with GG (70.3% and 4.1% OA frequency, respectively) much more than individuals buried without any goods (Table 6.59).

Dental pathologies

The investigation of dental pathologies with regard to differences between the defined burial groups revealed intriguing information. Considering caries (App. 6, Table 23), only a slight tendency is observable for individuals buried without GG to show a lower frequency of caries than those buried with GG (Table 6.59). In the analysis of the male sample, more meaningful disparities are present: Males buried without any GG did not show any carious lesions, a finding that is in strong contrast to the prevalence of caries in males buried with GG (62.8%, p = .012*, FET), and even more at variance with those males found with GG but without weaponry (relative caries frequency 90.9%, p = .002**, FET; App. 6, Table 23; Table 6.59). This means that in this case, we can identify males buried with GG that excluded weaponry as a distinct subgroup, characterized by remarkably high caries rates, possibly indicating a difference in diet. The finding of distinctive patterns for carious lesions is complemented by a significant difference in caries rates regarding the three grave types (p = .048*, FET), again rather prevailing in the male sample than in the female group: those individuals buried in coffins show considerably higher prevalence rates (60.4%) than those interred in 'simple' burials (37.9%) or chamber graves (35.5%).

Because peri-apical disease (App. 6, Table 24) can be connected at least in part to the occurrence of caries, it is not surprising to see the same trends for the prevalence of peri-apical disease to caries frequencies. There is a strong prevalence of peri-apical disease in males with GG, as opposed to those without any (Table

6.59). However, no comparable difference was noted in the female sample.

Periodontal disease and AMTL (App. 6, Table 25 and 26) are more prevalent in males buried without GG. Interestingly, they are completely absent in those males buried with GG but without weaponry. Among the females, AMTL, but no periodontitis could be observed in those buried without goods. Overall, there is no difference between the sexes in the various grave types for the prevalence of these dental pathologies.

Trauma

At Pleidelsheim, 97 intact burials were observable for differences in trauma frequencies, with 19.5% of male burials and 97.8% of female burials forming the groups “GG but no weaponry”. A highly significant difference could be found in the prevalence of trauma between those individuals buried with GG and those buried with GG, but without weapons at Pleidelsheim (χ^2 = 6.894, df = 1, N = 138, p =.009**), as well as when comparing all three types of burial accoutrement (p = .013*, FET; App. 6, Table 27).

When viewed in more detail, this derives from the male sample, as only those males buried with GG show any trauma (31.7%), healed or peri-mortem, but such trauma is absent among those males without weaponry or without any GG. There is a tendency for a statistically significant difference between the three burial equipment variations (p = .066, FET; Table 6.59). This indicates that not only males buried without any GG, but also those buried with GG yet without weaponry, led a life that was probably less prone to experiencing trauma, be it accidental or related to interpersonal violence and therefore to weaponry directly, and it suggests that a connection exists between the prevalence of trauma at Pleidelsheim and weapon burials, which will be explored in Chapter 6.3.

Considering the females, despite the very low numbers of traumatic injuries in Pleidelsheim, these cases only occurred in females who came to be buried with GG (App. 6, Table 27; Table 6.59).

Considering the various types of burial, no significant difference could be uncovered regarding trauma frequencies for individuals buried in coffins, ‘simple’ graves or chamber graves. Interestingly, however, two of the males with peri-mortem injuries with sharp-force characteristics (Skel. PH 244 and PH 229) were buried in a chamber grave. A closer examination of male burials only, however, did not reveal any notable difference between the burial types and trauma rates for the male population.

6.2.2.2 Neresheim

Table 6.60 presents the comparative overview for the frequencies of each skeletal variable examined in the particular defined burial groups from the cemetery of Neresheim, as well as the results of tests for statistical significance. Detailed records of the number of cases presenting a particular condition or appearing as unaffected can be found in App. 6, Tables 28 - 42.

Table 6.60: Neresheim - Overview of condition frequencies (%) by sex and subgroup and significant outcomes

Lesion	Males				Females		
	GG	no GG	GG NW	p - value	GG	no GG	p - value
skeletal pathology							
tibial periostitis (% affected)	15.4	25.0	0.0	NS	8.3	11.1	NS
maxillary sinusitis (% affected)	7.7	0.0	12.5	NS	20.8	5.6	NS
trauma (% affected)	16.7	25.0	14.3	NS	13.0	6.3	NS
DJD, extra-vertebral (% affected)	41.7	75.0	42.9	NS	34.8	37.5	NS
OA[a)] (% affected)	8.3	100.0	0.0	.047*	8.7	6.3	NS
spondylosis (% affected)	66.7	75.0	60.0	NS	40.0	50.0	NS
spondyloarthrosis (% affected)	44.4	50.0	40.0	NS	25.0	45.5	NS
Schmorl's nodes (% affected)	66.7	100.0	66.7	NS	23.1	40.0	NS
Cribra orbitalia (% affected)	66.7	66.7	62.5	NS	44.4	61.5	NS
dental pathology							
enamel hypoplasia (% with > 1 lesion)	62.5	100.0	50.0	NS	58.8	55.6	NS
caries (% affected)	55.6	66.7	75.0	NS	52.4	46.7	NS
peri-apical disease (% affected)	22.2	33.3	50.0	NS	9.5	13.3	NS
periodontal disease (% affected)	22.2	0.0	25.0	NS	9.5	0.0	NS
AMTL (% affected)	66.7	66.7	75.0	NS	57.1	60.0	NS

[a)] as evidenced by eburnation; [#] strong tendency; * significance at p < .05 level, **significance at p < .01 level

Indicators of childhood stress

Among the 43 intact burials observable for CO in Neresheim, no significant difference in the prevalence of CO was discernible (App. 6, Table 28). Of all male burials with GG, 88.9% did not include weaponry, but also for this subgroup, the CO rate (62.5%) was almost equal to those of males with or without GG (in both, 66.7% of CO are present; Table 6.60). Female intact burials did not contain any items of weaponry and can therefore be disregarded for further analysis.

For differences in the occurrence of DEH, 36 intact burials could be analyzed (App. 6, Table 29), with 50% of all male burials with GG being devoid of weaponry. There are no significant differences between any of the studied groups. Equally, there was no statistically significant difference in the prevalence of CO or DEH between individuals buried in coffins, ‘simple’ graves or chamber graves in Neresheim (App. 6, Table 28 and 29).

There are seven observable cases of intact burials in which CO and DEH occurred together (M = 3, F = 4). Of these, one male and two females were buried without GG, while only one male’s burial contained weaponry. Again, no statistically significant difference was found, indicating no association between childhood stress indicators and status in Neresheim.

Indicators of stress: Non-specific infections

Between those individuals buried with GG or with GG but without weaponry (61.5% of the male sample), and those buried without grave inclusions among the 59 intact graves observable for tibial periostitis as well as maxillary sinusitis in Neresheim, no significant difference was observable regarding the prevalence of either of the two conditions (App. 6, Table 30 and 31).

A slight tendency for increased periostitis rates in those burials without any GG is present (Table 6.60). Interestingly, none of the males buried without weaponry but otherwise endowed with GG shows tibial periostitis (Table 6.60), but a separate test here, against either of the other two groups, did not yield significant results either. Similar to patterns at Pleidelsheim, no difference regarding tibial periostitis was found between individuals buried in different grave types (App. 6, Table 30), but also in this cemetery, it is notable that individuals in chamber burials do not show any tibial periostitis, whereas those buried in coffins show 11.3 % prevalence and those in simple graves 15 %.

Therefore, only a tendency can be suggested regarding the informational value of tibial periostitis for a differentiation between “groups”, namely that individuals buried without GG, and / or in simple graves, exhibit increased rates of this condition.

As opposed to patterns at Pleidelsheim, where maxillary sinusitis seems to affect preferentially those individuals found in graves without any goods, in Neresheim, rates are comparatively low in these individuals (0% in males), contrasting frequencies in burials with GG (Table 6.60). Moreover, in Neresheim, it is the female population buried in chamber graves which shows no evidence for maxillary sinusitis at all; in the male population, those buried in chamber graves show the highest prevalence compared to those buried in more simple graves (66.7% as opposed to 5.0% in coffin burials and 5.6% in simple graves, with a highly statistically significant difference (p = .003**, FET)).

Hence, we must assume that in Neresheim, there is some underlying connection between grave elaboration and this type of non-specific infection, the analysis of which with regard to sex and age between and among populations did not reveal anything noticeable, but proves elucidating when examined in conjunction with variables associated with the funerary context. The correlation of maxillary sinusitis and better-furnished burials poses an interesting parallel to the findings regarding female chamber burials at Pleidelsheim and, given the nature of this non-specific infectious disease, suggests a common environment, different from those shared with other subgroups, for a certain group of females (those buried in chamber graves) at Pleidelsheim and a certain group of males at Neresheim.

Vertebral degenerative joint disease

In the burial groups identified at Neresheim, patterns for vertebral DJD prevalence generally follow those observed in Pleidelsheim, but with more faintly expressed tendencies, and with 55.6% of all male burials fitted with GG lacking weaponry affected by vertebral degeneration. Twenty out of 38 individuals from intact burials observable for spondylosis showed this type of vertebral degenerative disease, but no significant difference was found between individuals in any of the three burial groups or grave types (App. 6, Table 32). For males and females, the relative frequency of spondylosis is higher in those individuals without any GG than in those equipped with goods (Table 6.60).

Examining spondyloarthrosis rates in the 40 observable intact burials for this condition, we encounter the same result (App. 6, Table 33), both with regard to burial groups as well as grave types, and again with this condition being more prevalent in individuals without any GG (Table 6.60) and no difference with regard to biological sex.

The results for spondylolysis rates are shown in App. 6, Table 34, and despite the very small sample size, rendering a statistical analysis inappropriate, it is remarkable that the condition is found exclusively in individuals buried with GG. Furthermore, albeit not with statistically significant results (App. 6, Table 34), individuals buried in 'simple' graves show the highest tendency for displaying spondylolysis (Fig. 6.35).

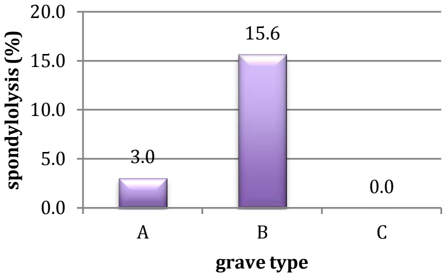


Fig. 6.35: Neresheim - Prevalence of spondylolysis in different grave types

In contrast to the results from Pleidelsheim, where Schmorl's nodes (SN) primarily occurred in those individuals buried with GG, the frequency pattern of SN at Neresheim follows the hitherto observed pattern uncovered overall for vertebral DJD, with those individuals buried without any GG also showing the highest prevalence rates for SN, especially in males (100%; Table 6.60). Apart from this finding, no significant differences were found in SN prevalence among burial groups or grave types (App. 6, Table 35).

All observations for vertebral DJD at Neresheim suggest generally different patterns of physical stress with degenerative effects on the vertebral column in this population, compared to Pleidelsheim. Individuals of the group without any GG are more affected than those whose graves were provided with goods, and despite only two cases for observable chamber burials, only spondylosis and SN occurred in these individuals (App. 6, Table 32 and 35).

Extra-vertebral degenerative joint disease and osteoarthritis

Fifty-five intact burials could be analysed for the occurrence of extra-vertebral DJD and OA, 35 of which contained GG and provided a subgroup of 58.3% of male burials not containing weaponry. Twenty-two individuals displayed evidence of DJD, but no significant differences were found when dividing them into separate burial groups, nor when examining them with respect to different types of grave (App. 6, Table 36). Similar to what could be observed in Pleidelsheim, frequencies of DJD are slightly higher in individuals buried without GG, albeit this difference is more expressed in males (GG: 41.7%, GG NW: 42.9%, no GG: 75%) than in females (Table 6.60).

Among the three types of burial mode, only those individuals buried in chamber graves show a considerably lower frequency of DJD (2.8%) than those interred in coffins (14.2%) or, with highest prevalence, those buried in 'simple' graves (21.7%; App. 6, Table 36), with no recognizable bias for biological sex.

Also the distribution of (severe) OA, appearing in six cases, initially does not seem to show a penchant for any of the given burial groups in Neresheim, as no significant difference could be discerned between any of the three in the total sample (App. 6, Table 37). In females, those buried with GG seem to show a slightly higher frequency of OA than those buried without goods (Table 6.60). Among the male individuals showing OA, a significant difference became apparent between the three types of accoutrement (p = .047*, FET): males buried without any GG show significantly higher rates of OA than those buried with GG (Table 6.60), although the very low number of observable cases does not permit any further insights here.

With regard to grave types, we find the same pattern as with DJD. Those interred in 'simple' burials show the highest frequency of OA (4.7%), followed by individuals buried in coffins (1.9%), and not a single case of severe OA in individuals found in chamber graves (App. 6, Table 37).

Ultimately, the findings at Neresheim regarding DJD and OA do complement those made for vertebral DJD: individuals buried without any GG, as well as in simple graves, and especially males, seemed to have been affected most by these degenerative changes, while it is difficult to identify any other discrete subgroup regarding these conditions in this cemetery population.

Dental pathologies

The examination of dental disease patterns among the different burial groups as well as grave types in Neresheim led to no discernible significant difference in any of the examined pathologies. Some indicative tendencies could be observed which are divergent from the patterns observed in Pleidelsheim, however. Considering the occurrence of caries (App. 6, Table 38), females buried with GG showed a slightly higher prevalence of dental decay than those buried without (Table 6.60). And as in Pleidelsheim, males endowed with GG but not with weaponry exhibit the highest caries rates of the male sample (75%, Table 6.60). Yet this is followed by males without any GG (66.7% of caries presence), while those males buried with GG including weaponry show the lowest frequency of carious lesions (55.6%).

The same distribution can be seen for peri-apical disease frequencies in the male sample (Table 6.60; App. 6, Table 39), only with overall lower frequencies of pathological changes. In female cases, we find a trend for slightly more peri-apical disease in those buried without GG than in those buried with goods.

Regarding periodontal disease (App. 6, Table 40), Neresheim males and females only exhibit pathological changes in those burials with GG, and AMTL is comparable among all groups under study (App. 6, Table 41; Table 6.60).

Trauma

Fifty-five intact burials were observable for possible difference with regard to the distribution of trauma rates among the defined groups and grave types, with 58.3% of all males with GG having been buried without weaponry. The distinctive tendency for males with GG, including weapons, to show the highest trauma frequency is not encountered at Neresheim (App. 6, Table 42). No significant differences in trauma rates were found in either the total population or among males or females, or between various grave types. Instead, in the male sample, the highest prevalence of trauma (25%) can be seen in the group of individuals buried without any GG, while those males buried with GG are only affected in 16.7% of cases, and those without weaponry even less so, in only 14.3% of cases (Table 6.60). Among females, those buried with GG show a slightly higher frequency of trauma (13%) than those buried without GG (6.3%, Table 6.60), a similar finding to the female sample at Pleidelsheim.

Although we have only one case of trauma in the Neresheim sample which occurs in an individual interred in a chamber grave (App. 6, Table 42), it is noteworthy that in relative comparison with the trauma rates among individuals buried in coffins (12.5% trauma) or 'simple' burials (14% trauma), this case constitutes a trauma frequency of 20% for individuals in chamber burials.

6.2.3 Relationships between biological and social variables

The collation and analysis of indicators of skeletal health in relation to archaeologically-defined burial groups and grave types encountered in the cemeteries of Pleidelsheim and Neresheim provide an informed picture of the various groups of individuals, not only limited to males and females or different age groups that compose the Alamannic populations of Pleidelsheim and Neresheim. It remains to investigate if the defined 'burial groups' are, in fact, only artificial, maintained to tether social status distinctions, or if the observed skeletal variables and their variations point to substantial differences between these groups.

In the context of the results obtained by examining possible differences in skeletal health between the various burial groups and grave types, a supplementary correlation analysis was conducted separately by sex and population for overall relationships of skeletal variables examined in individuals from Pleidelsheim and Neresheim with archaeological correlates, with the additional consideration of whether an association may exist between a particular variable and burial wealth (i.e. more, and a greater variety of, goods), as indicated by AT. In addition to stature and childhood stress indicators, this analysis focused on those biological correlates that could be actively 'acquired' by varying lifestyles and activities. 'Weapons' are included in these tables as a separate entity for the sake of completeness, although a detailed analysis of weapon burials follows in section 5.2.3.

a) Pleidelsheim

Table 6.61: Pleidelsheim - Relationships of biological and archaeological variables - Males

PH M	weapons[1]	GG[1]	AT[2]	GG excl. weapons[1]
Stature[3]	NS	NS	NS	NS
Cribra orbitalia[1]	NS	NS	NS	NS
Enamel hypoplasia[1]	NS	NS	NS	NS
Schmorl's nodes[1]	NS	NS	NS	NS
Spondylosis[1]	NS	NS	NS	NS
Spondyloarthrosis[1]	NS	NS	NS	NS
OA[1]	NS	NS	NS	NS
DJD[1]	NS	NS	.021*	NS
Trauma[1]	.007**	NS	NS	NS
weapon-related trauma	NS	NS	NS	NS
Tibial periostitis[1]	NS	NS	NS	NS

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Notes on significant results:

Relationship	Significance	Comments
*trauma * weaponry*	ρ = .394, N = 46	positive relationship
*DJD * AT category*	ρ = .306, N = 57	positive relationship

The observations made up to this point regarding males in Pleidelsheim concur with the findings developed from examination of the patterns of skeletal health prevalence and their interrelations (cf. Chapter 6.1). The occurrence of relatively severe forms of DJD and principally activity-related degenerative changes, as well as high trauma rates, can now be ascribed with certainty to the burial group 'M GG' (males buried with GG), which is characterized by comparatively high frequencies of trauma, OA, SN, DEH, and peri-apical disease, i.e. signs of high physical stress, primarily related to activity-related changes, in combination with a preponderance of injury rates. It is interesting to find a positive relationship between DJD and the number of AT (Table 6.61), as during the antecedent analysis, only a tendency to this effect was indicated. It suggests that with increasing burial wealth, we can expect to observe increased rates of DJD in the male population of Pleidelsheim. The positive correlation of trauma with weaponry (Table 6.61) accentuates an observation already made in the analysis of trauma in Pleidelsheim and bespeaks a strong connection to the fourth group 'M W' (males buried with weaponry) that will be discussed subsequently (Chapter 6.3).

From this, we can distinguish the burial group 'M N GG' (males buried without GG), marked by non-specific infectious stress indicators, vertebral and extra-vertebral DJD, CO, as well as periodontal disease and AMTL. It denotes a group that was subject to generally higher levels of physical stress and more susceptible to (non-specific) infectious disease, possibly having been predisposed to conditions during childhood that could lead to anaemia or similar causes for CO.

Finally, presumably mainly distinguished by dietary differences, as very high rates of dental caries are the only real evidence, we can assume the existence of another discrete subgroup, 'M GG NW' (males buried with GG but without weaponry).

Considering females in Pleidelsheim, a division recognizable by elements of skeletal characteristics seems to be stronger than in the male population. The positive correlation of stature and the number of AT (Table 6.62) has been described at length in Chapter 6.2.1.

Table 6.62: Pleidelsheim - Relationships of biological and archaeological variables - Females

PH F	**weapons[1]**	**GG[1]**	**AT[2]**	**GG excl. weapons[1]**
Stature[3]	ND	NS	.027*	NS
Cribra orbitalia[1]	NS	NS	.001**	NS
Enamel hypoplasia[1]	NS	.017*	NS	NS
Schmorl's nodes[1]	ND	NS	NS	NS
Spondylosis[1]	ND	NS	NS	NS
Spondyloarthrosis[1]	ND	NS	NS	NS
OA[1]	NS	NS	NS	NS
DJD[1]	NS	NS	NS	NS
Trauma[1]	NS	NS	NS	NS
weapon-related trauma	ND	ND	ND	ND
Tibial periostitis[1]	NS	.035*	NS	NS

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Notes on significant results:

Relationship	**Significance**	**Comments**
*Stature * AT*	ρ = .330, N = 45	positive relationship
*cribra orbitalia * AT*	ρ = -.482, N = 41	inverse relationship
*enamel hypoplasia * GG*	ρ = .372, N = 41	positive relationship
*tibial periostitis * GG*	ρ = -.283, N = 56	inverse relationship

Considering variables of skeletal health, we recognize the occurrence of presumably favourable conditions during childhood, in combination with increased levels of spondylosis, in the burial group 'F GG' (females buried with GG), which, similarly to M GG, is characterized by highest frequencies of trauma, OA, spondylosis, SN, and periodontal disease, but at the same time, the lowest rates of CO among the total female sample. This also agrees with the findings of an inverse relationship between CO rates and AT (Table 6.62) and thus closes a circle; stature, a childhood stress indicator, as well as burial wealth, can be indicative a female status in Pleidelsheim.

The positive relationship found for the presence of DEH and GG (Table 6.62) emphasizes the finding of by trend higher DEH rates in females buried with GG, albeit the highest frequency of DEH was found in those females buried without any items of 'weaponry' (seax, arrows). It would be difficult, however, to propose the presence of a concrete subgroup (F GG NW) on the basis of this health indicator or, indeed, the absence of a seax or arrows, alone.

An inverse relationship between tibial periostitis and GG denotes characteristics of the distinct burial group 'F N GG' (females buried without GG), which shows the highest prevalences of non-specific infectious stress indicators, vertebral and extra-vertebral DJD and is thus matching with the group 'M N GG' in its attributes for individuals buried without GG in Pleidelsheim.

b) Neresheim

Table 6.63: Neresheim - Relationships of biological and archaeological variables - Males

NE M	weapons[1]	GG[1]	AT[2]	GG excl. weapons[1]
Stature[3]	NS	NS	NS	NS
Cribra orbitalia[1]	NS	NS	NS	NS
Enamel hypoplasia[1]	NS	NS	NS	NS
Schmorl's nodes[1]	NS	NS	NS	NS
Spondylosis[1]	NS	NS	NS	NS
Spondyloarthrosis[1]	NS	NS	NS	NS
OA[1]	NS	NS	NS	NS
DJD[1]	NS	NS	NS	NS
Trauma[1]	NS	NS	NS	NS
weapon-related trauma	ND	ND	ND	ND
Tibial periostitis[1]	NS	NS	NS	NS

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Table 6.64: Neresheim - Relationships of biological and archaeological variables - Females

NE F	weapons[1]	GG[1]	AT[2]	GG excl. weapons[1]
Stature[3]	ND	NS	NS	ND
Cribra orbitalia[1]	ND	NS	NS	ND
Enamel hypoplasia[1]	ND	NS	NS	ND
Schmorl's nodes[1]	ND	NS	NS	ND
Spondylosis[1]	ND	NS	NS	ND
Spondyloarthrosis[1]	ND	NS	NS	ND
OA[1]	ND	NS	NS	ND
DJD[1]	ND	NS	NS	ND
Trauma[1]	ND	NS	NS	ND
weapon-related trauma	ND	ND	ND	ND
Tibial periostitis[1]	ND	NS	NS	ND

[1]categorical variable (presence / absence); [2]multiple categorical variable; [3]numerical variable; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

The altogether negative results of tests for relationships between biological and "social" variables (Table 6.63 and Table 6.64) highlight what has been noticeable throughout; if measured by skeletal health in relation to archaeological correlates, there seems to be less of a social division traceable in Neresheim than is the case in Pleidelsheim. Life in Neresheim was certainly influenced by different circumstances, with other demands on the physical health and different results for observable traits on the skeletal remains, and the present results indicate that, overall, lifestyle or activities may have been less varying between males and females. However, it is still possible to identify separate groups, even though less marked by significant correlations with material culture.

Males buried with GG (M GG) in Neresheim are marked by the absence, rather than presence, of changes to skeletal health; they present the lowest frequencies in the total sample of trauma, DJD and SN, as well as of dental disease. It can be assumed that also the tallest males can be found in this burial group, given the tendency indicated for a relationship between a very high number of AT and stature. M GG NW quite certainly form a subgroup also in this population, as they exhibit the highest frequencies of dental pathology, indicating a difference in diet, as well as of maxillary sinusitis.

In the group 'M N GG' (males buried without GG), we find those individuals with evidence for the highest levels of tibial periostitis, risk for trauma, vertebral and extra-vertebral DJD (including SN), and DEH, i.e. predominantly indicators of physical stress and activity, in the latter case with an apparently different aetiology than in Pleidelsheim where trauma is mainly recorded in males buried with GG.

Among the females in Neresheim, those with GG and those without can be differentiated. The first group, ‘F GG’, is characterized by comparatively high rates of maxillary sinusitis, trauma, spondylosis, dental caries and periodontal disease, thus except for the high rates of sinus infection, mirroring what could be found for F GG in Pleidelsheim. Those females defined by skeletal changes as highly physically stressed and active, with a less favourable childhood (i.e. high frequencies of tibial periostitis, DJD (incl. SN), CO, peri-apical disease and AMTL), we find in the group ‘F N GG’. Overall, we can define burial groups in Neresheim that are coherently identifiable by archaeological *and* skeletal markers.

6.3 Weapon burials - The skeletal evidence

The final group to be examined consists of those individuals interred in 'weapon burials'. As the archaeological analysis has shown, items of weaponry were found in female burials in both Pleidelsheim and Neresheim, but they do mainly consist of seax and arrows. In the light of the question of whether a 'weapon burial' automatically represents a 'warrior burial', the focus will be on those males buried with weapons and whether or not they form an identifiable subgroup, distinguished archaeologically as well as biologically, that denotes a separate social status.

The burial group 'males with weapons' (M W) comprises those males buried with an item of weaponry, regardless of weapon genre as identified in Chapter 5.3. Special consideration of weaponry assemblages for a more detailed distinction of weapon burials will be given on a case-by-case basis, if relevant. This burial group will be contrasted to the group 'males without weapons' (M NW), encompassing all burials with and without GG, as well as to the already described number of male burials interred with GG but without weapons (M GG NW), in order to distinguish a weapon burial rite from the general rite of grave good inclusion.

6.3.1 Stature and the Weapon Burial

Table 6.65 shows that the mean statures for males buried with weapons (174.7 cm) and those buried without (173.5 cm) in Pleidelsheim do not differ to any significant degree from each other.

Table 6.65: Male stature and weapon burial

Site	Individuals with weaponry			Individuals without weaponry		
	mean*	var.**	sample size	mean*	var.**	sample size
Pleidelsheim	174.7	24	31	173.5	25	21
Neresheim	176.9	16	8	177.4	38	19

*average body height in cm
**variation (difference between smallest and largest value in the sample, in cm)

In Neresheim, we may find a slight differentiation in that males buried with weapons display a lower variation in stature and include taller individuals than those buried without weapons. However, the small sample size makes interpretation to this effect difficult and should be considered with caution. This direct comparison of groups indicates that men with weapons were *not* taller than their counterparts without weapons within a population[101], contrary to findings from contemporary cemeteries of other populations (e.g. Härke 1992) or, indeed, to conclusions made previously regarding Alamannic populations (e.g. Czarnetzki *et al.* 1983).

Table 6.66: Male stature and weapon types

n˚ of WT	PH cases	stature*	NE cases	stature*
0	11	173.6	6	175.2
1	6	172.0	3	172.6
2	7	174.2	1	178.3
3	11	175.0	0	-
4	3	173.7	0	-
5	2	178.6	0	-

*average body height in cm

Tying in with observations made regarding male stature and burial wealth (cf. Chapter 6.2.1), male stature was correlated with the number of weapon types (WT) found in intact male burials in Pleidelsheim and Neresheim (Table 6.66), categorizing the weapon burials from 'lightly armed' (1+ WT) to 'heavily armed' (full

[101] This stature differential, or rather a lack thereof, would be the same if stature averages calculated with the Pearson (1899) or Breitinger (1938) formulae were used.

set of weaponry, i.e. five WT, cf. Chapter 5.3.1). While we encounter cases stretching the whole range of weapon accoutrements at Pleidelsheim, at Neresheim, one intact burial with two WT presents the maximum number of WT found in this heavily robbed cemetery.

Statistically, no significant correlation could be found between the number of WT and the average stature estimates for males in weapon burials (Pleidelsheim: $\rho = .137$, $p = .398$; Neresheim: $\rho = .090$, $p = .804$). However, despite the only very low numbers of observable cases, there is undeniably a tendency discernible for males buried with the maximum number of weapons to be taller on average than those buried with fewer WT - even in Neresheim, albeit one case cannot provide a basis for an informed interpretation.

In conclusion, these samples are not substantial enough to support a proposition towards a positive association between weapon burial, status and stature. There is no identifiable difference between men buried with and those buried without any weapons, which puts the observations from the weapon burials at Pleidelsheim and, despite a small sample size, Neresheim, at variance with those from other early medieval cemeteries. It also makes the hypothesis of increasing rank being reflected in an increasing number of weaponry, but also burial wealth in male interments altogether, unsupportable, for we should have seen a corresponding increasingly significant difference between no or few AT or WT and the highest number of these items, if this had been the case. What is perceivable, however, is a tendency for males interred with a full set of weaponry accounting for a generally high number of GG and AT in a burial, to be slightly taller than those buried with fewer goods (and weaponry), which might be augmented to represent a significant difference if larger sample sizes were available. Therefore, it may be that a difference in status is indeed reflected in these burial accoutrements, yet only those males with very high numbers of AT and WT form a discrete group, with no other distinctions relating to the proposed status distinctions discernible.

6.3.2 Health indicators for males in weapon burials

a) Pleidelsheim

Table 6.67 provides a comparative overview of the frequencies for each skeletal variable under study as occurring in the groups ‘M W’ versus ‘M NW’, as well as the results of tests for statistically significant differences between these two groups. Detailed records of the number of cases presenting a particular condition or appearing as unaffected in burials with and without weaponry can be found in App. 6, Tables 43 - 49. Additionally, the frequencies resulting for previously examined burial groups as identified in Chapter 6.2.2 are listed for comparative purposes.

Table 6.67: Pleidelsheim - Weapon burials: Condition frequencies (%) by subgroup and significant outcomes

Lesion	Males					
	GG	no GG	GG NW	weapons	no W	p - value
skeletal pathology						
tibial periostitis (% affected)	11.9	33.3	22.2	10.8	29.6	NS[#]
maxillary sinusitis (% affected)	7.1	33.3	0.0	8.1	7.4	NS
trauma (% affected)	31.7	0.0	0.0	43.2	4.0	.001**
weapon-related trauma (% affected)	-	-	-	37.5	0.0	NS[#]
DJD, extra-vertebral (% affected)	85.7	100.0	80.0	81.8	76.0	NS
OA[a)] (% affected)	70.3	33.3	0.0	10.5	4.2	NS
spondylosis (% affected)	52.8	60.0	50.0	48.5	57.1	NS
spondyloarthrosis (% affected)	35.3	50.0	42.9	31.3	30.0	NS
Schmorl's nodes (% affected)	69.7	50.0	71.4	71.4	64.7	NS
Cribra orbitalia (% affected)	39.4	60.0	39.1	35.7	45.5	NS
dental pathology						
enamel hypoplasia (% with > 1 lesion)	43.8	33.3	39.1	38.5	37.5	NS
caries (% affected)	62.8	0.0	90.9	53.1	62.5	NS

[a)] as evidenced by eburnation; [#] strong tendency; * significance at $p < .05$ level, **significance at $p < .01$ level

Indicators of childhood stress

The comparison of weapon burials with those unaccompanied by weaponry among the 47 male burials observable for CO resulted in no significant difference regarding the prevalence of this childhood stress indicator (App. 6, Table 43). Males without weapons show a slightly higher rate of CO (45.5%) than those interred in weapon burials (35.7%; Table 6.67) as well as in those males buried with GG but without weapons. Overall, though, we find a pattern that agrees with previous findings regarding the frequency of CO in separate burial groups.

The same applies to the occurrence of DEH, where, in fact, we are faced with almost identical numbers of the presence and absence of developmental enamel defects in weapon burials compared to the remainder of the male cemetery population (App. 6, Table 43), and as such with no difference regarding the occurrence of this skeletal marker (Table 6.67).

Similar to the findings made examining overall GG attribution, the skeletal markers of childhood stress do not provide any information that would support differential living conditions for those males interred in weapon burials.

Indicators of stress: Non-specific infections

Males in weapon burials show a strong tendency to have the lowest prevalence of tibial periostitis (10.8% in a sample of 37 weapon burials), compared to those without weapons ($p = .057$; App. 6, Table 44) as well as to other males in the subcategory 'M GG NW (Table 6.67). This reflects previous findings and accentuates the fact that individuals without GG were by far most at risk of suffering from this type of non-specific infection, while most males who show evidence of this condition in the burial category 'M GG' are also those who were buried with weapons.

Whilst maxillary sinusitis is predominantly found in males without GG in the entire male population, the picture changes somewhat when examining weapon burials as a separate group; some 8.1% of all males buried with weapons exhibit changes to their maxillary sinus consistent with sinusitis, while those buried without weapons amount to 7.4% of maxillary sinusitis occurrence (App. 6, Table 44; Table 6.67). This, in itself, does not show any significant difference, yet presents a noteworthy tendency in this cemetery sample. Only a small number of males buried with GG may present evidence of this non-specific infection, but individuals from weapon burials constitute a large part of them. Moreover, this differs highly from the situation of M GG NW. In this burial group, no signs of sinusitis could be found

(Table 6.67), which permits the conclusion that males in weapon burials, and not males with GG in general, were more prone to develop these pathological changes as response to living or environmental conditions.

Vertebral degenerative joint disease

Observations made for the occurrence and relative frequencies of vertebral DJD in males from weapon burials correspond almost entirely with the results obtained in the analysis of males endowed with GG versus other burial groups, with no significant difference between M W and M NW in the prevalence of spondylosis, spondyloarthrosis, spondylolysis or Schmorl's nodes (SN; App. 6, Table 45). Thus, males in weapon burials show a slightly lower prevalence of spondylosis (48.5%) than M NW (57.1%), almost identical to M GG NW (50%; Table 6.67). SN occur more frequently in males buried with weapons (71.4%) than in those buried without GG (64.7%), but are undifferentiated from males buried with GG in general (Table 6.67). Spondylolysis (App. 6, Table 45) was only observed in one weapon burial, but also presents the only observed case in the male population overall, in a man who died in young middle adulthood and exhibited multiple indicators of heavy physical stress (Skel. PH 102, cf. App. 6, Table 7).

Finally, only spondyloarthrosis presents a small deviation from the previously observed balance of M N GG exhibiting much higher rates of this type of vertebral degeneration. Comparing M W with M NW, absolutely no difference can be discerned between the two groups (Table 6.67), suggesting that spondyloarthrosis does not distinguish individuals in weapon burials, perhaps because generally relatively high rates of physical stress, in particular activity-related stress, may have entailed increased rates of spondyloarthrosis in the group M W.

Extra-vertebral degenerative joint disease and osteoarthritis

That higher rates of physical stress may affect those individuals interred in weapon burials is also indicated by the slightly, albeit not significantly, higher rate of extra-vertebral DJD in M W (81.8%), as opposed to M NW (76%; Table 6.67; App. 6, Table 46), whereas with regard to the male population divided by the presence or absence of GG overall, M N GG were found to exhibit the highest prevalence of DJD. The rate with which degenerative changes to the joints occur in those males buried with weapons is not, however, different to the one displayed in the group M GG NW (81.8%). Therefore a distinction as to whether we are merely seeing a breakdown of the percentage presented in the group 'M GG' cannot be made.

A significant difference in the prevalence of DJD between burials with and without items of weaponry does appear, however. This is the case between the females buried with weaponry and those buried without at Pleidelsheim (p = .015*, FET; App. 6, Table 46), as well as when testing females buried with weaponry against those buried with GG except weaponry (p = .018*, FET). The significance denotes the absolute lack of extra-vertebral DJD in females buried with items of weaponry - Skel. PH 13 and PH 52 (both YMA) were found with a seax as well as arrows, Skel. PH 183 (OA) and PH 195b (MTA) with arrows only, but in robbed graves - in comparison with other female burials. This may signal that items of weaponry in female burials are indeed connected to status, with those women exhibiting fewer signs of physical stress, although this cannot be established from one skeletal marker alone and must therefore be considered as very tentative.

The examination of (severe) OA in weapon burials resulted in a reflection of previous results for M GG versus M N GG (App. 6, Table 47). Males buried with weapons show a higher prevalence of OA (10.5%) than those buried without weapons (4.2%) or without weapons but other GG (0%; Table 6.67), permitting the inference of (severe) OA being characteristic for the group M W (from old middle adulthood onwards, cf. Chapter 6.1.2.4).

A note on degenerative changes to the hip

Since a survey of the available data demonstrated that every male buried with weaponry and / or horse riding equipment in Pleidelsheim also exhibits degenerative changes of the hip joint, regardless of how skeletally healthy otherwise they were, it was decided to test whether a positive relationship could be found between the observed high prevalence rates of changes to the right hip joint (cf. Chapter 6.1.2.4) and weapon burials.

To recollect, at Pleidelsheim, 51.4% of individuals show degenerative changes to the right hip, while only 28.6% exhibit changes of the left hip, with a significant difference between males and females. A test of the possible correlation between the occurrence of DJD to the right hip and several factors from the burial context resulted in the following:

Is this occurrence related to…	***age?***	***grave type?***	***GG?***	***weapons?***
…in males	**PARTIALLY (age + weapon burial)**	NS	NS	NS
…in females	NS	NS	NS	(NS)

The occurrence of degenerative changes of the hip joints showed no significant correlation with grave type, the number of GG, or the presence of weaponry, and, in females, also no significant relationship with age.

In males, however, young middle adults (YMA) exhibit considerably more degenerative changes to their right hip joint than in any other age category (χ^2 = 11.545, df = 1, N = 38, p = .042*), as well as opposed to their left hip (p = .041*, FET). That means age is a factor in this observation of predominant DJD in the right hip joint.

Considering weapon burials only, YMA M have considerably more degenerative changes to their right hip (60%) than to their left (10%, p = .029*, FET), as well as more than in any other age category among weapon burials (p = .018*), i.e. these degenerative changes to the right hip are more prevalent at young adult age than at any other stage of life. In order to test these results, the same analysis was conducted for males in burials without weaponry, but no significant difference could be found between DJD in the right and left hip in any age category. Thus, the difference in DJD to the right versus the left hip is not coupled with weapon burials versus non-weapon burial, but within the group M W, there is an age-related association of DJD of the right hip.

Conducting an identical analysis for the individuals from Neresheim, where the dichotomy of DJD between right and left hip joint is far less pronounced than in Pleidelsheim (cf. Chapter 6.1.2.4), no significant difference was found for the prevalence of degenerative changes of the hip joints with regard to age or burial group, nor any correlation between components of the burial context. However, considering weapon burials only, all males were found to show degenerative changes of the right hip joint, unilaterally except for the single case of a MTA male who had bilateral DJD of the hips.

Dental health: Caries

With regard to the distinctive patterns of caries prevalence found among the burial groups, the occurrence of this dental pathology was also examined for individuals in weapon burials (App. 6, Table 48). Given the high caries prevalence in M GG NW (90.9%), it was not surprising that no significant difference could be observed between M W (53.1%) and M NW (62.5%, Table 6.67), but rather between M W and M GG NW ($p = .033^*$, FET). While males buried without weapons but with other GG exhibit the highest frequencies of carious lesions, it is now the group M W that shows the lowest prevalence of caries in this population.

Trauma & weapon-related trauma

The highly significant difference ($p = .001^{**}$, FET) that can be observed when comparing trauma frequencies of M W (43.2%) with those of M NW (4%, Table 6.67; App. 6, Table 49), already emerged earlier during this analysis. While M buried with GG but no weapons show no trauma at all (Table 6.67), a highly significant difference exists between this group and males buried with weapons ($p = .000^{**}$, FET; App. 6, Table 49). Individuals in weapon burials appear to bear the highest risk of trauma in the Pleidelsheim population. Among the modes of trauma, we find three cases of healed blunt-force trauma of the cranium (cf. App. 6, Table 7), and six male individuals with evidence of ante- or peri-mortem sharp-force trauma of the cranium and postcranial skeleton (healed: Skel. PH 82, PH 116, PH 120, all MTA; peri-mortem: Skel. PH 103 (OMA), PH 229, PH 224 (both YMA), App. 6, Table 7). Although blunt-force trauma can also be considered weapon-related, it was deemed more revealing to examine the occurrence of sharp-force trauma in this sample with regard to a possible association between the functional use of GG and lesions of the skeleton. Not unexpectedly, given that 37.5% of individuals in weapon burials exhibit sharp-force trauma, it was found that there is a very strong tendency for males in weapon burials to show evidence of weapon-related trauma (App. 6, Table 49), however, compared to other types of traumatic lesions, those caused by sharp-force trauma do not show a preponderance (App. 6, Table 49).

That weapon-related trauma does not show a bias towards males buried in elaborate graves or with particular artefactual wealth can be demonstrated by having a closer look at Skel. PH 103 and Skel. PH 244.

The skeleton of an OMA M, buried in a coffin found intact, together with sword, arrows and axe, as well as tools, flint stone and a knife, showed a small well-healed depression fracture, caused by blunt-force trauma, in the midline region of the frontal bone of the cranium. Further examination of the skeleton revealed a cut mark with no traces of healing, situated anteriorly on the head of the right humerus, just above the lesser tubercle (Fig. 6.36). This incision was caused by a sharp-force implement, such as a sword, either by a stabbing motion into the right shoulder or a slash across the shoulder and anterior body, which, if coming from the front, would have been carried out with the opponents' right hand steering the sword or similar weapon in a downward motion.

Fig. 6.36: Skel. PH 103 - Unhealed cut mark of the right humeral head

While for Skel. PH 103 the cause of death remains indeterminate, and it can only be assumed that sharp-force trauma would have played a significant role, the skeleton of a YMA male (Skel. PH 244) tells the story of much more vigorous peri-mortem sharp-force trauma. He was buried in a chamber grave, which was found intact and to contain a shield as well as arrows, pottery and flint stones, but notably no sword or similar implement.

His postcranial skeleton exhibits the following lesions (all without any trace of healing):

- multiple cut marks located on superior side of the left clavicle (Fig. 6.37), six being surface lesions, while one consists of a deep cut leading to spalling of the bone;

- two deep incisions located on the left distal humerus, running medio-distally above the medial epicondyle, as well as a deep cut into the anterior side of the humerus, just below the midshaft, with subsequent spalling at the lesion and an unrelated post-mortem fracture of the bone (Fig. 6.38);
- multiple cut marks located on the anterior side of the distal left radius (Fig. 6.39);
- multiple cut marks and one deeper sharp-force lesion with spalling of the bone, located on the anterior side of the right proximal ulna, below the coronoid process (Fig. 6.40);
- two incisions located on the left iliac blade, antero-laterally.

Fig. 6.37: Skel. PH 244 - Unhealed cut marks of the left clavicle, superior side

Fig. 6.39: Skel. PH 244 - Unhealed cut marks of the left anterior distal radius

Fig. 6.38: Skel. PH 244 - Unhealed sharp-force lesions of the anterior left humerus

Fig. 6.40: Skel. PH 244 - Unhealed cut marks and spalling of the right anterior ulna, superior side

This injury pattern is congruent with an attack coming from the front and, given this individual would have held a shield, such as the one found in his burial, with his right hand and arm, it is likely that his left side would have sustained more injuries than his right. However, this is only a conjecture; if he would have used the shield he was buried with in a fight, it is debatable why no sword, seax or similar item of use in active conflict was found with his remains.

The finding of burial accoutrements belonging to the 'weaponry' category, but not associated with indicators of trauma found on the bones, is not restricted to this individual. For instance, in a case of healed sharp-force trauma of the cranium (Skel. PH 82; lower left parietal and occipital region), the mature adult male, interred in a coffin found intact, was buried with a lance, arrows, knife and belt. The assemblage of weaponry types found in weapon burials at Pleidelsheim does not permit one to interpret the actual use of these items by the individual buried with them, nor, as demonstrated with these cases, to directly link these implements with the cause of death of the deceased.

b) Neresheim

Table 6.68 provides a comparative overview of the frequencies for each skeletal variable examined for the groups 'M W' versus 'M NW', as well as the results of tests for statistically significant differences between these two groups. Detailed records of the number of cases presenting a particular condition or appearing as unaffected in burials with and without weaponry can be found in App. 6, Tables 50 -

55. Furthermore, the frequencies resulting for previously examined burial groups as identified in Chapter 6.2.2 are listed for comparative purposes.

Table 6.68: Neresheim - Weapon burials: Condition frequencies (%) by subgroup and significant outcomes

Lesion	Males					
	GG	**no GG**	**GG NW**	**weapons**	**no W**	**p - value**
skeletal pathology						
tibial periostitis (% affected)	15.4	25.0	0.0	18.2	20.0	NS
maxillary sinusitis (% affected)	7.7	0.0	12.5	18.2	6.7	NS
trauma (% affected)	16.7	25.0	14.3	25.0	12.1	NS
DJD, extra-vertebral (% affected)	41.7	75.0	42.9	45.5	57.1	NS
OA[a)] (% affected)	8.3	100.0	0.0	9.1	7.1	NS
spondylosis (% affected)	66.7	75.0	60.0	50.0	56.5	NS
spondyloarthrosis (% affected)	44.4	50.0	40.0	25.0	40.9	NS
Schmorl's nodes (% affected)	66.7	100.0	66.7	83.3	66.7	NS
Cribra orbitalia (% affected)	66.7	66.7	62.5	66.7	60.9	NS
dental pathology						
enamel hypoplasia (% with > 1 lesion)	62.5	100.0	50.0	62.5	77.8	NS
caries (% affected)	55.6	66.7	75.0	40.0	71.4	NS

[a)] as evidenced by eburnation; [#] strong tendency; * significance at $p < .05$ level, **significance at $p < .01$ level

Indicators of childhood stress

In Neresheim, only three weapon burials could be observed for CO, resulting in a non-significant difference for the prevalence of this condition between those males buried with weapons and those without (App. 6, Table 50). Males in weapon burials seem to have a tendency for a marginally higher rate of CO (66.7%, Table 6.68), yet interestingly, the man endowed with weapons showing no evidence of CO was buried in a chamber grave, and despite being a disturbed burial, was still found with three weapon artefacts, as opposed to the other two males with healed CO, who were found with only one weapon type (WT) and in a coffin or 'simple' burial.

There is also no significant difference in the prevalence of DEH between those males buried with weapons and those buried without at Neresheim (App. 6, Table 50), albeit here the relative frequencies indicate an inclination towards males buried without weapons exhibiting higher rates of DEH (Table 6.68). This can be explained, however, by the generally high prevalence of enamel defects found in males buried without any GG in this cemetery, and presents an identical distribution of findings as made for the general distribution of GG in this sample. Thus, no association is present between childhood stress indicators and weapon burials in the skeletal remains of this cemetery.

Indicators of stress: Non-specific infections

Considering the occurrence of tibial periostitis (18.2%) in 37 observable weapon burials (M W) in Neresheim, there is almost no difference to those males buried without weapons (20%), only to males buried with GG except weaponry (0 %; Table 6.68; App. 6, Table 51). This suggests an increased risk for sustaining tibial periostitis among those individuals buried with weapons, in contrast to those where weaponry was deliberately left out of the grave context.

Exclusively males with GG seemed to have suffered from maxillary sinusitis in Neresheim, and in particular those buried in chamber graves (cf. Chapter 6.2.2.2). This can now be complemented by the observation that predominantly males buried with weapons suffered from this condition (18.2%), as opposed to those without weaponry (6.7%; with other GG: 12.5%; Table 6.68), although no significant difference was found between the burial groups (App. 6, Table 51). Not unexpectedly, males suffering from sinusitis were also found to have been buried in chamber graves, whereas all those without any signs of this non-specific infection were found in less elaborate burials.

Vertebral degenerative joint disease

The distribution of relative frequencies of vertebral degenerative changes in males from weapon burials essentially follows the observations made before regarding spondylosis, spondyloarthrosis, spondylolysis and SN, without any significant differences considering the occurrence of these pathological changes in weapon and non-weapon burials (App. 6, Table 52). They do add, however, to the identification of those interred with weapons forming a distinct group.

Spondylosis rates are marginally higher in M NW (56.5%) than in M W (50%), yet in the light of these groupings, M W display the lowest rates for spondylosis overall, with M GG NW (60%) still showing a higher prevalence than M W (Table 6.68). Spondyloarthrosis left the Neresheim males buried with weapons distinctly less affected (25%) than those buried without weapons (40.9%), even if buried with GG (40%; Table 6.68). Spondylolysis did occur in one individual buried without weapons and in two individuals with weapons (App. 6, Table 52), in one of the latter cases in combination with an *os acromiale* in a young adult male (Skel. NE 94, cf. App. 6, Table 8) - buried in the most simple grave type (B). SN, registered as highly prevalent in males without any GG in Neresheim, resurface in M W in comparatively higher frequency (83.3%) than in M NW (66.7%), distinguishing males buried with weapons from those buried without weapons as well as without any GG (66.7%; Table 6.68). With regard to vertebral DJD, this is the most significant finding, as it places males from weapon burials in Neresheim on par with those from

Pleidelsheim and highlights an association with higher rates of SN with M W.

Extra-vertebral degenerative joint disease and osteoarthritis

No significant difference could be found for rates of extra-vertebral DJD in M W (45.5%) compared to M NW (57.1%, Table 6.68; App. 6, Table 53), following the results obtained when considering the comparability of GG distribution in general, i.e. males without GG, or weapons, show increased frequencies of DJD. While for (severe) OA, this also persists with regard to GG versus no GG, OA rates are almost equal between M W (9.1%) and M NW (7.1%, Table 6.68), with M GG NW displaying no cases of OA, differentiating this subgroup from individuals endowed with weapons.

Dental health: Caries

At Neresheim, where caries rates indicate a differentiation of the group 'M GG NW' (see above), individuals with GG were lowest in comparison. This pattern is maintained when comparing caries prevalence in M W (40%) to that in M N W (71.4%, Table 6.68), with no significant difference between either these two groups or M W versus M GG NW (App. 6, Table 54). Thus, here, as in Pleidelsheim, M W represents the group with the least susceptibility to carious lesions.

Trauma & weapon-related trauma

Although no injuries could be observed that point to weapon-related trauma in the Neresheim sample, the analysis of trauma frequencies among the weapon burials in Neresheim revealed that 25% of males buried with weaponry show evidence of trauma, a higher rate in comparison to M NW (12.1%, Table 6.68), albeit not statistically significantly different (App. 6, Table 55). This finding uncovers that while, in general, males without any GG show a comparatively high risk of sustaining injuries at Neresheim, males in weapon burials can be characterized by having suffered more frequently from trauma than those buried without weapons (Table 6.68).

6.3.3 "Warriors" in weapon burials?

The analysis of weapon burials in Pleidelsheim and Neresheim in the context of their biological evidence as well as with other 'burial groups' provides significant information regarding the identity of the individuals buried with these accoutrements as well as the question whether the archaeological categorisation of 'weapon burials' is meaningful in the overall characterization of these cemetery populations. Table 6.69 summarizes the palaeopathological characteristics uncovered that are relatively distinctive in their high prevalence for each male 'burial group' described and contextualizes the weapon burials in Pleidelsheim and Neresheim. Stature and burial accompaniments, including a more elaborate grave type, do not seem to be reliable factors from which a distinct biological and social status for individuals in weapon burials can be deduced. It is a combination of burial context and biological variables that reveals the distinctiveness of this group from other individuals in the cemetery.

Table 6.69: Distinctive palaeopathological attributes of male burial groups in Pleidelsheim and Neresheim

Site	*M W*	*M GG*	*M N GG*	*M GG NW*
Pleidelsheim	maxillary sinusitis trauma weapon-related trauma extra-vertebral DJD (severe) OA Schmorl's nodes	trauma (severe) OA Schmorl's nodes DEH peri-apical disease	tibial periostitis maxillary sinusitis extra-vertebral DJD spondylosis spondyloarthrosis CO periodontal disease AMTL	dental caries
Neresheim	maxillary sinusitis trauma (severe) OA Schmorl's nodes	(periodontal disease)*	tibial periostitis trauma extra-vertebral DJD (severe) OA(*) spondylosis spondyloarthrosis Schmorl's nodes DEH	maxillary sinusitis dental caries peri-apical disease periodontal disease AMTL [+spondylosis; CO]*

*Parentheses represent additional characteristics emerging when comparing M W with M GG or M GG NW only.

Considering Pleidelsheim, the group 'M W' is principally congruent with the larger group 'M GG', with only a few differentiating characteristics that set males in weapon burials apart from those buried without weapons. Males found in weapon burials are characterized by being exposed to a significant risk of trauma, including weapon-related injuries, as well as to high levels of physical stress mainly associated with intense physical activity, rather than solely degeneration.

At Neresheim, the group 'M W' is much more strongly biologically defined than at Pleidelsheim, in that it is clearly set apart from 'M GG': we find relatively high prevalences of maxillary sinusitis, trauma, (severe) OA and Schmorl's nodes that define males buried in 'weapon graves'. Moreover, these findings are, with the exception of increased DJD rates, concordant with those for M W in Pleidelsheim, defining a 4th burial group of individuals which seems in agreement with what would characterize a "warrior", an individual engaged in warfare and combat, and high physical activity overall. However, the present results also demonstrate that the relational patterns in both cemeteries are too complex for a simplistic division of ‘wealthy’ and ‘poor’ burials, and, especially, the denomination of “warriors” and “others”.

6.4 Conclusion: Biological and Social Variables - Significant outcomes

This chapter has not only illustrated the differential health and disease patterns encountered in males and females from Pleidelsheim and Neresheim, they also corroborate findings made regarding age, sex and burial context. They reveal a life and environment leaving divergent signatures on the remains of the people who formed these two Alamannic populations (the significant findings are summarized below). The present results have also provided evidence for biologically and artefactually distinct groups that may be defined by either more general factors such as sex and age, but indicate even more a differentiation by variable social, economic or possibly even legal status. At Pleidelsheim, the patterns uncovered highlight variable lifestyles for both men and women. The biological variation in Neresheim seems less clear than in Pleidelsheim, with fewer discernible correlations between burial patterns and skeletal indicators of health and disease, which potentially emphasizes less well-defined social boundaries in this population. The Neresheim population appears to have sustained a generally harder life than the population at Pleidelsheim.

The dialogue between biological and archaeological data aids the distinction of separate groups. It is indisputable that a superficial distinction into “rich” and “poor”, bound to artefactual remains and with inferences deduced from individual status in life and death, is ineffectual and disregards the multi-layered characteristics of these societies. The results show that ‘burial groups’ described here primarily indicate differences in lifestyle, which subsequently may either generate, or be caused by, economic factors and status. A direct reflection of status from the burial context alone, however, cannot be established. The complex patterns of health indicate a complex division of labour and important differences with regard to physical activity. Hence, the combined analysis of patterns of physical activity and material culture will significantly enhance and complement our understanding of these two Alamannic populations.

I. Pleidelsheim (PH)

Significant Outcomes

Males

stature:

- mean: 174.2 cm ± 6.2

trauma:

- M > F
- positive correlation of trauma & weapons as GG
- 6 cases of weapon-related trauma, 3 of which peri-mortem injuries

childhood stress indicators:

- inverse relationship with spondylosis, trauma & tibial periostitis

nonspecific infectious disease:

- *maxillary sinusitis*:
  tendency for N GG > GG
  none in chamber graves

vertebral degenerative joint disease:

- *Schmorl's nodes:*
  M > F
  M in 'simple' graves < chamber graves or coffins
  tendency for weapons > no weapons
- *spondyloarthrosis:*
  M > F, sign. so in MTA

extra-vertebral degenerative joint disease & OA:

- *DJD:*
  M > F, esp. in YMA
  right hip > left hip
  positive correlation with number of AT
  OA: tendency M > F

dental pathology:

- *caries:*
  GG NW > GG > N GG
  individuals in coffins > 'simple' or chamber graves
- *AMTL:* M > F

Females

stature:

- mean: 162.0 cm ± 7.2
- the taller, the more AT (positive correlation), the less childhood stress indicators (inverse relationship)

trauma:

- only in F GG

childhood stress indicators:

- *cribra orbitalia:*
  inverse relationship with number of AT
- *enamel hypoplasia:*
  positive correlation with number of GG

nonspecific infectious disease:

- *tibial periostitis:*
  tendency for N GG > GG / GG N W
  inverse relationship with GG (i.e. the more GG, the less prevalence of tibial periostitis)
- *maxillary sinusitis:*
  tendency F in chamber graves > F in coffins or simple graves

vertebral degenerative joint disease:

- *spondyloarthrosis:*
  N GG > GG / GG N W
- the better childhood conditions, the more *spondylosis*

extra-vertebral degenerative joint disease & OA:

- *DJD:*
  right hip > left hip
  F in coffins > chamber or 'simple' burials
  F with items of weaponry (seax, arrows) show no DJD, < GG no weaponry

dental pathology: NS

Overall population: Significant Outcomes

- ***stature:*** general tendency for individuals in chamber burials to be taller than those in more simple graves
- ***tibial periostitis***: N GG > GG / GG NW
- ***maxillary sinusitis***: N GG > GG / GG NW
- ***spondylosis***: tendency for individuals in chamber burials < coffins > simple burials
- ***spondyloarthrosis:*** tendency for individuals in chamber graves < coffins or 'simple' graves
- ***DJD***: right hip > left hip; tendency N GG > GG / GG NW
- ***OA:*** by trend, GG > N GG
- ***dental caries***: individuals in coffin burials > individuals in simple or chamber burials; GG > no GG

Weapon burials

- ***stature***: slight tendency for M with full set of weaponry & high number of AT to be taller
- ***DJD***: right hip > left hip in YMA
- ***"set" of skeletal variables in rel. high frequencies:*** maxillary sinusitis, trauma, DJD, OA, SN

II. Neresheim (NE)

Significant Outcomes

Males

***stature**:*

- mean: 177.2 cm ± 7.4
- M buried in chamber graves >(taller) M in coffins >(taller) M in ‘simple’ burials

***trauma**:*

- N GG > GG / GG NW

***childhood stress indicators**:*

- *enamel hypoplasia:*
  M > F

***nonspecific infectious disease**:*

- *maxillary sinusitis:*
  M in chamber burials > M in coffin or simple burials

***vertebral degenerative joint disease**:*

- *Schmorl’s nodes:*
  M > F
  inverse relationship with stature
- *spondyloarthrosis:*
  M > F

***extra-vertebral degenerative joint disease & OA**:*

- *DJD:*
  M > F, esp. in MTA
  M > F in right hip joint
- *OA:*
  tendency M > F
  N GG > GG / GG NW
  ‘simple’ graves > coffins > chamber graves (no OA)

***dental pathology**:*

- *caries:*
  tendency for highest caries and peri-apical disease rates in M GG NW, lowest in M GG

Females

stature:

- mean: 164.1 cm ± 7.2
- F buried in chamber graves >(taller) F in ‘simple’ graves >(taller) F in coffins
- tendency for taller F to have more AT

trauma:

- GG > N GG

childhood stress indicators: NS

nonspecific infectious disease:

- *maxillary sinusitis:*
  none in chamber graves

vertebral degenerative joint disease: NS

extra-vertebral degenerative joint disease & OA:

- *DJD:*
  left shoulder > right shoulder
  F > M in elbow & left wrist
- *OA:*
  tendency for GG > N GG

***dental pathology**:* NS

Overall population: Significant Outcomes

- ***tibial periostitis**:* tendency N GG > GG / GG NW; highest prevalence in ‘simple’ graves
- ***maxillary sinusitis: :*** tendency N GG > GG
- ***spondylosis:*** N GG > GG
- ***spondyloarthrosis:*** N GG > GG
- ***spondylolysis:*** only in individuals with GG; highest prevalence in individuals in ‘simple’ graves
- ***Schmorl’s nodes:*** N GG > GG
- ***DJD:*** tendency N GG > GG / GG NW; by trend, ‘simple’ graves > coffins > chamber graves
- ***OA:*** by trend, ‘simple’ graves > coffins > chamber graves
- ***trauma:*** individuals in coffins > ‘simple’ graves > chamber graves

Weapon burials

- ***stature**:* slight tendency for M with full set of weaponry to be taller
- ***“set” of skeletal variables in rel. high frequencies:*** maxillary sinusitis, trauma, DJD, OA, SN

III. Comparison of Pleidelsheim and Neresheim

Significant Outcomes

Males

trauma*:*

- clavicular fracture patterns in M PH with different aetiology to NE

childhood stress indicators*:*

- *enamel hypoplasia:*
  NE > PH

nonspecific infectious disease*:* NS

vertebral degenerative joint disease*:* NS

extra-vertebral degenerative joint disease & OA*:*

- *DJD:*
  PH > NE

dental pathology*:*

- *AMTL:*
  NE > PH

Females

trauma*:* NE > PH

childhood stress indicators*:*

- *cribra orbitalia:* NE > PH
- *enamel hypoplasia:* NE > PH

nonspecific infectious disease*:* NS

vertebral degenerative joint disease*:*

- *Schmorl's nodes:* PH > NE

extra-vertebral degenerative joint disease & OA*:*

- *DJD:*
  hip (bilaterally): PH > NE

dental pathology*:*

- *caries:* PH > NE
- *PAD:* PH > NE
- *AMTL:* NE > PH
- *POD:* PH > NE

Overall population comparison: Significant Outcomes

- ***spondyloarthrosis****:* tendency NE > PH
- ***spondylolysis:*** tendency NE > PH
- ***enamel hypoplasia****:* NE > PH
- ***DJD****:* PH > NE
- ***AMTL****:* NE > PH
- ***POD****:* PH > NE

7 Tracing Alamannic Activities

The present results suggest that the populations from Pleidelsheim and Neresheim show considerable variation in their lifeways and skeletal indicators of health and disease, which point to complex patterns of differential physical activity and thus potentially to the presence of distinctive groups within these populations.

An investigation of the physical manifestations of activity as indicated by musculoskeletal stress markers (hereafter MSM), or more accurately, entheseal changes (hereafter EC), appearing on the bone complements previous findings and provides corroborating evidence for acquired sexual dimorphism in these traits both within and between the two Alamannic populations.

This chapter will provide a description of entheseal changes observed in the skeletal evidence of the adult populations from Pleidelsheim and Neresheim, and the information they can provide regarding activity patterns and variation in habitual activity for these Alamannic males and females. While no conjecture will be made about what these people actually did, differences in muscle use between individuals buried in different modes, with and without grave goods, as well as between males buried with and without weapons, will be explored, followed by an investigation into possible links between MSM and the use of material items as evidenced by artefacts in the grave.

Statistical methods employed in this chapter comprise independent sample t-tests for the overall evaluation of differences between groups (e.g. sex and / or age) on the basis of mean muscle scores (hereafter MMS), as well as non-parametric tests (Mann-Whitney U test, Kruskal Wallis' H test), as the present values are categorical data on an ordinal scale. Correlations between EC and age, as well as between skeletal and material variables are analysed by Spearman's Rank Correlation Coefficient test, with the null hypothesis rejected at $\alpha = .05$ (*, significant) and .01 (**, highly significant).

This study controlled for biological age and sex, but not for body size. It assumes a general underlying influence on the development of EC by factors such as body size and robusticity (e.g. Weiss 2003b; 2004), however, these are not considered to be determining factors in this analysis[102]. As opposed to age categories employed so far, data for MSM will be categorized into three large age groups, i.e. young adult (YA, 16 - 25 years), middle adult (MA, 26 - 45 years) and old adult (OA, 46+ years), due to the nature of entheseal changes (cf. Chapter 3.3.2) and for reasons of clarity in their presentation. Inter-period differences within the cemetery sites are deemed to be lower than intra- and inter-site differences in activity patterns, and a division into periods would have resulted in sample sizes too small for appropriate statistical analysis, therefore, the analysis focuses on males and females from the entirety of cemetery populations.

[102] The notion that big elements require big muscles and therefore larger attachment sites is regarded as controversial, considering a multifactorial influence of factors on changes of muscular entheses (cf. for instance Weiss 2007).

7.1 Entheseal changes in the populations of Pleidelsheim and Neresheim

7.1.1 Prevalence of entheseal changes

The observation of the presence of entheseal changes (EC) encountered in the individuals at Pleidelsheim and Neresheim, initially without an assessment of severity as denoted by a differentiation into minor (= B scores) and major (= C scores) osseous changes, forms the basis for the investigation of activity patterns. A detailed distribution of the prevalence of muscle scores can be found in App. 7, Table 1 (Pleidelsheim) and Table 2 (Neresheim). In the graphs, significantly higher prevalences emerging in a comparison of groups are marked *(p ≤ .05) and **(p ≤ .01).

7.1.1.1 Pleidelsheim

Fig. 7.1 and Fig. 7.2 provide an overview of the prevalence of EC in the upper (hereafter UL) and lower limb (hereafter LL) of males and females at Pleidelsheim. It becomes apparent that males show overall more changes to muscle insertions in UL (Fig. 7.1) and especially LL (Fig. 7.2) than females (App. 7, Table 3).

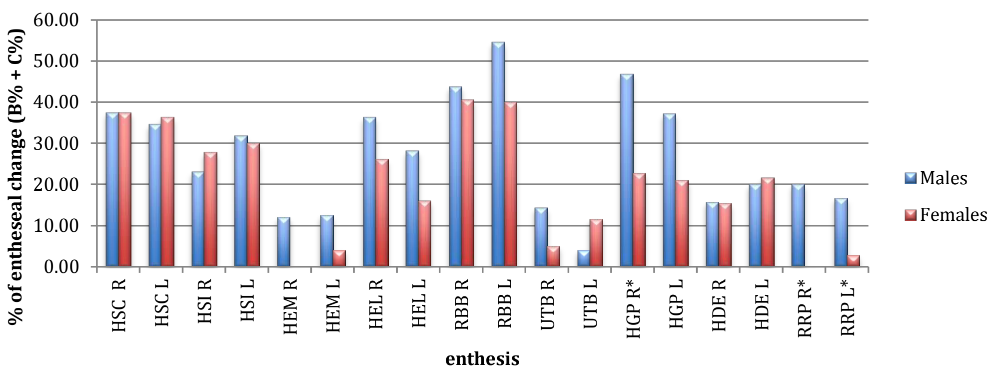


Fig. 7.1: Pleidelsheim - Prevalence of entheseal changes, UL

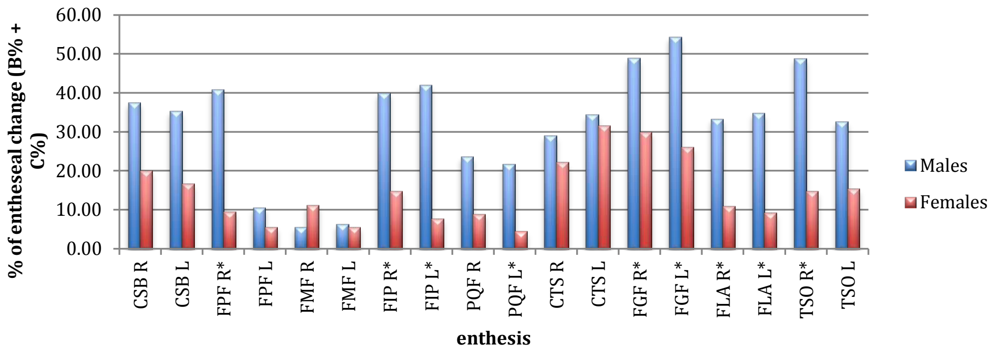


Fig. 7.2: Pleidelsheim - Prevalence of entheseal changes, LL

In the UL (Fig. 7.1), these expressions are significantly stronger in the insertions for the right *M. pectoralis major* as well as, bilaterally, for *M. pronator teres* (App. 7, Table 3). Albeit not statistically significant, EC of the attachments of the flexor muscles (HEM) in both right and left humeri appear much stronger in males than in females. Females display a higher prevalence of EC than males in the insertions for the left *M. deltoideus, M. subscapularis* and *M. triceps brachii*, as well as the right *M. supra- and infraspinatus*.

In the LL (Fig. 7.2), males show significantly stronger EC of the attachments of right *M. gluteus minimus* and *maximus* (the latter bilaterally), *M. iliopsoas* (left), *Mm. vastus medialis, adductor magnus and longus* (bilaterally), right *M. soleus*, and left *Mm. quadriceps femoris* (App. 7, Table 3). Except for those caused by the right *M. gluteus medius*, all EC are more prevalent in the male population.

Pleidelsheim: Sexual dimorphism

While the comparison of EC in males and females has demonstrated some statistically significant differences in osseous changes to muscle insertions between the two groups, the calculation of relative sexual dimorphism within the population (Fig. 7.3) permits insight into which muscles were markedly more frequently used in the two groups. Hence, we can observe that although the majority of muscles show greater signs of physical stress in males, *Mm. supra- and infraspinatus* and *M. deltoideus* (bilaterally), and the left *M. triceps brachii* in the UL, as well as the right *M. gluteus medius* demonstrate visibly greater signs of stress in females at Pleidelsheim (Fig. 7.3).

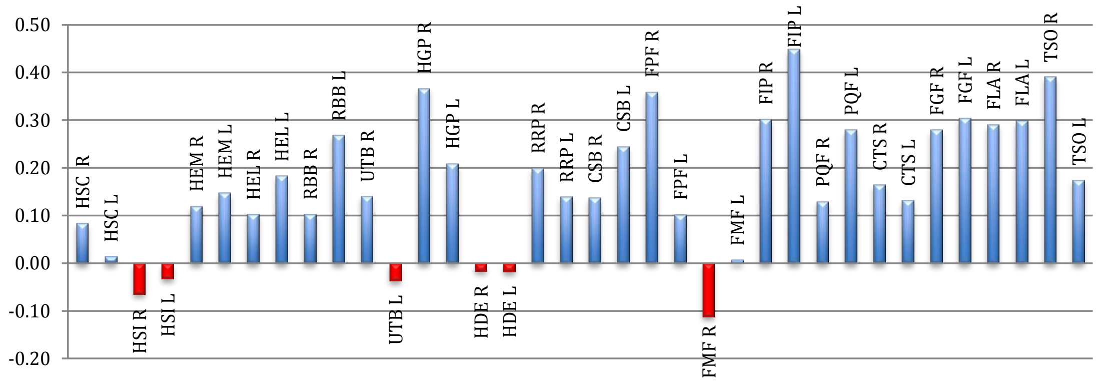


Fig. 7.3: Relative sexual dimorphism at Pleidelsheim (calculated by male MMS minus female MMS, divided by male MMS x 100; M = positive values, F = negative values)

7.1.1.2 Neresheim

Fig. 7.4 and Fig. 7.5 present the prevalence of EC in UL and LL of males and females at Neresheim. Also in this population, males show overall a higher prevalence of EC than do females (App. 7, Table 3).

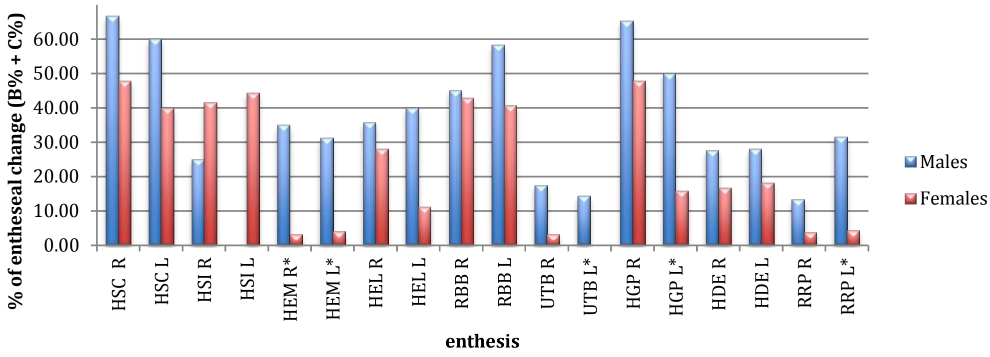


Fig. 7.4: Neresheim - Prevalence of entheseal changes, UL

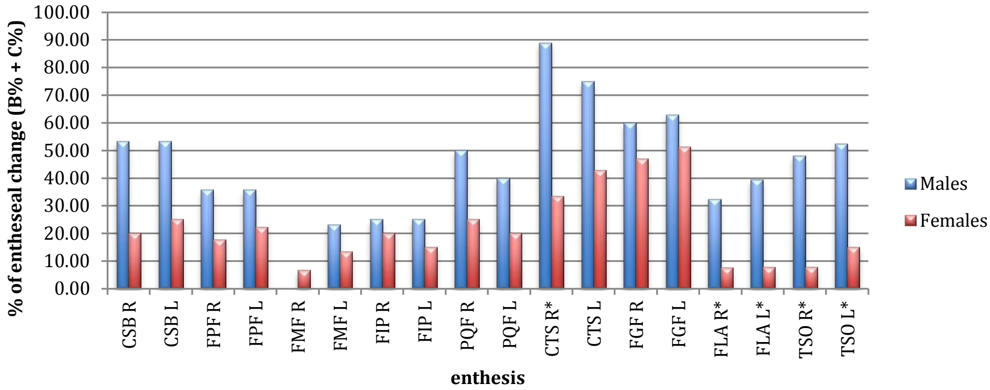


Fig. 7.5: Neresheim - Prevalence of entheseal changes, LL

In the UL (Fig. 7.4), significantly stronger EC can be observed for the flexor muscles (HEM) attaching to the medial epicondyle of the humerus, as well as on the left side for the entheses of *M. pectoralis major, M. pronator teres*, and, by tendency, *M. biceps brachii*. However, EC are significantly stronger in females for *M. supra- and infraspinatus* (bilaterally; App. 7, Table 3).

In the LL (Fig. 7.5), males show higher frequencies of EC for all but one muscle insertion, significantly so for the right and left *Mm. triceps surae*, and, similarly to males in Pleidelsheim, for *Mm. vastus medialis, adductor magnus and longus*, and *M. soleus*, but also for the muscles of the right posterior thigh (CSB; App. 7, Table 3).

win As at Pleidelsheim, changes to the insertion for the right *M. gluteus medius* are more frequently encountered in females than in males.

Neresheim: Sexual dimorphism

Most muscles have a higher MSM score for Neresheim males than for females. The observed distinctive differences of EC in females are markedly visible in the analysis for sexual dimorphism (Fig. 7.6). Although only the left enthesis for *Mm. supra- and infraspinatus* shows statistically significantly more changes in females, it becomes apparent that this applies to the highly frequent abduction and lateral rotation movement of both arms in females, together with distinctly greater signs of stress to the right *M. gluteus medius* in females from this population. Interestingly, a more frequent utilization of these muscles agrees with similar findings from Pleidelsheim (cf. Fig. 7.3).

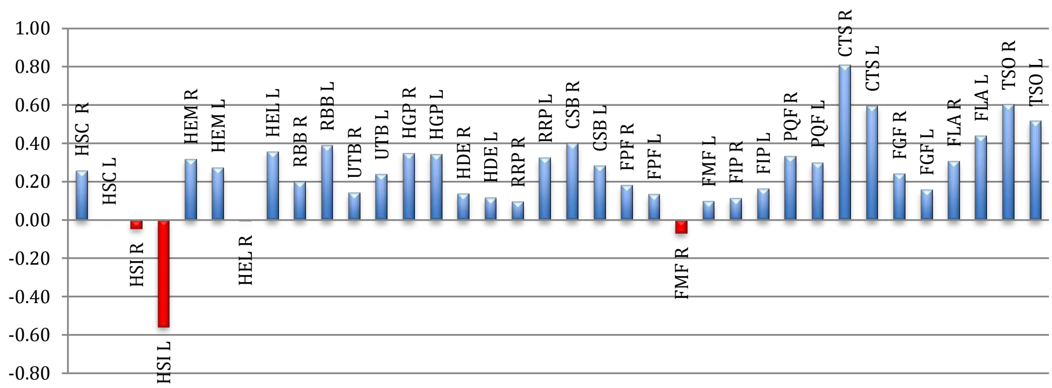


Fig. 7.6: Relative sexual dimorphism at Neresheim (calculated by male MMS minus female MMS, divided by male MMS x 100; M = positive values, F = negative values)

7.1.1.3 Inter-population comparison

With only a few exceptions, Neresheim males (Fig. 7.7, Fig. 7.8) and females (Fig. 7.9, Fig. 7.10) display generally a higher prevalence of EC than individuals at

Pleidelsheim. However, between the two male populations, there are no statistically significant differences to be found regarding EC in the UL (Fig. 7.7), except for the insertion of the left *Mm. supra- and infraspinatus* (App. 7, Table 3), which does not seem to have been highly stressed in the male Neresheim sample (Fig. 7.7). It is noteworthy that although at Pleidelsheim and Neresheim, males exhibit relatively strong changes to the humeral attachments of flexor muscles (HEM), at Neresheim this seems to be even stronger pronounced than at Pleidelsheim. Considering the LL (Fig. 7.8), significant differences could only be observed for the insertions of the *Mm. triceps surae*, for which males in Neresheim show the highest prevalence of EC overall (App. 7, Table 3).

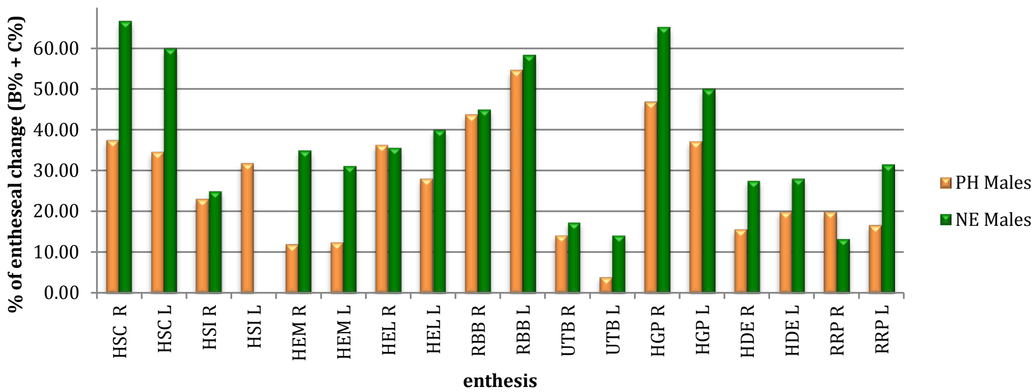


Fig. 7.7: Prevalence of entheseal changes - Comparison of males, UL

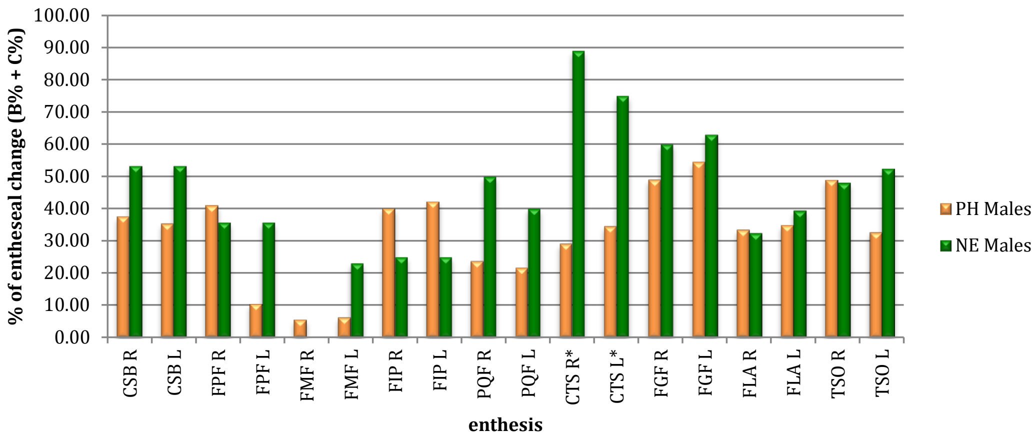


Fig. 7.8: Prevalence of entheseal changes - Comparison of males, LL

Also when comparing the female populations, Neresheim individuals show overall a higher prevalence of EC (Fig. 7.9; Fig. 7.10), although for the UL, no significant differences could be discerned (Fig. 7.9; App. 7, Table 3). Notably, females in both populations exhibit the same degree of EC in the attachment for the flexors at the left humeral medial epicondyle (HEM L), while signs of stress to one of the major forearm extensors, the left *M. triceps brachii*, could only be discerned in females from Pleidelsheim (Fig. 7.9). Considering the LL, females at Neresheim have significantly more EC to the insertion of the left *M. gluteus maximus* (Fig. 7.10; App. 7, Table 3), but also its right counterpart as well as the *Mm. triceps surae* show a comparatively high prevalence of EC in Neresheim females. Although females show much lower prevalences of EC at the insertions for the vasti and adductor muscles (FLA) as well as *M. soleus* than males in both populations, females at Pleidelsheim exhibit slightly greater changes to the entheses of these muscle groups than those at Neresheim (Fig. 7.10).

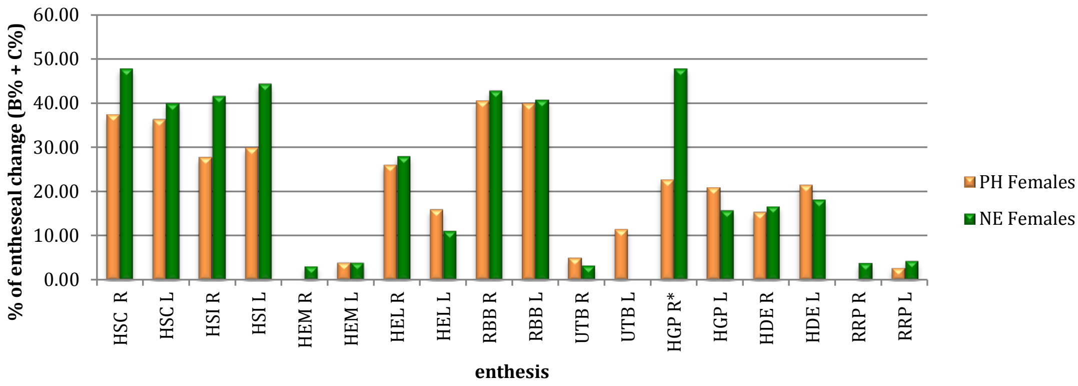


Fig. 7.9: Prevalence of entheseal changes - Comparison of females, UL

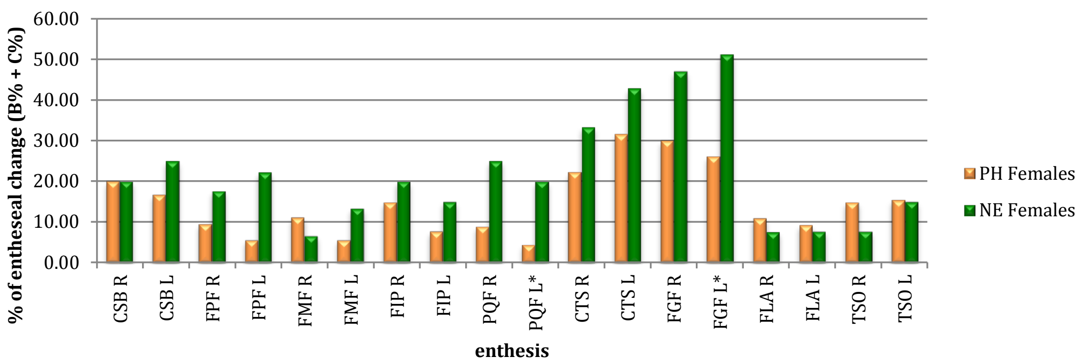


Fig. 7.10: Prevalence of entheseal changes - Comparison of females, LL

7.1.2 General patterns of entheseal changes and muscle use

While general comparisons between the sexes and populations under study provided some indications towards patterns of muscle use, the rank ordering of mean muscle scores (MMS) from high to low clarifies the findings through examination of scores of specific muscles and synergistic muscle sets in males and females, as well as in comparison of the two populations. Rank order profiles are an established means of analysing variations in intensity of muscle use (e.g. Peterson 1998 ; Eshed *et al.* 2004 ; Molnar 2006). This ranking reveals not only which entheses show the strongest changes induced by frequent muscle use, but strong parallels in rank ordering, especially of the most frequently expressed scores, may be suggestive of parallels in tasks or an equivalence in muscular demands, while dissimilar rank ordering can point to individual and divergent patterns of activity (Peterson 1998). Thus, MMS values for males and females in Pleidelsheim (App. 7, Table 4) and Neresheim (App. 7, Table 5) were assigned a rank of 1 - 36 in descending order, with the six highest ranking muscles marked in bold (App. 7, Tables 4 and 5) and circled in red[103] in the graphs (Figures 7.11 - 7.18).

7.1.2.1 Pleidelsheim

a) Upper limb

Males and females at Pleidelsheim display similar rank order profiles (Fig. 7.11 and Fig. 7.12) for EC with regard to several muscles (App. 7, Table 4). EC recorded bilaterally at the attachments for *M. biceps brachii* and *M. subscapularis* were ranked consistently high for males and females. Differences in muscle use can be observed in a high-ranking MMS for *M. pectoralis major*, suggesting high intensity bilateral use of this muscle in males (Fig. 7.11), emphasized by its significantly higher MMS when compared to that of females. Also the extensors of the right hand and fingers (HEL R) fall among the highest-ranking muscles for males. In females, indications for increased physical stress on the rotator cuffs is provided by the addition of high-ranking MMS for *Mm. supra- and infraspinatus* on both sides (Fig. 7.12), suggesting the highly frequent rotation and abduction of both arms as a

[103] Sometimes, this may result in more than six circled entheses and indicates that some entheses have the same MMS and therefore rank in the rank ordering profile.

motion distinctively common to females, especially when adding the distinct stress put on the entheses of *M. deltoideus* in females at Pleidelsheim (cf. Chapter 7.1.1.1, Fig. 7.3).

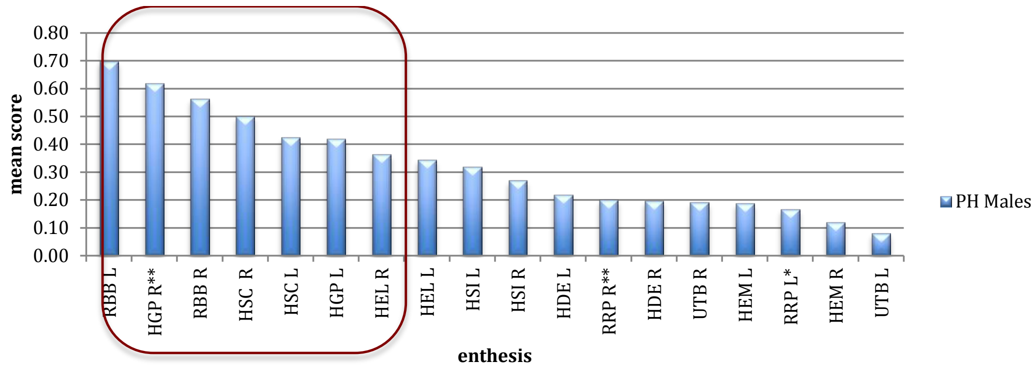


Fig. 7.11: Pleidelsheim - Rank ordering of MMS - Males, UL. */** indicate EC significantly higher than in F.

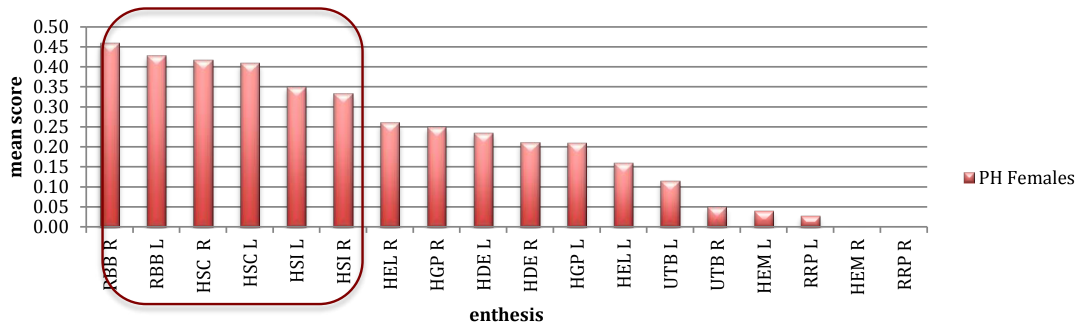


Fig. 7.12: Pleidelsheim - Rank ordering of MMS - Females, UL

b) Lower limb

In the LL, a greater variation can be noted regarding those attachments with the highest scores in males and females at Pleidelsheim (Fig. 7.13 and Fig. 7.14; App. 7, Table 4). Both groups share the right and left side attachments of *M. gluteus maximus* among their highest ranking MMS, as well as those of the right *M. iliopsoas* and *M. soleus*, the hamstring muscles of the right thigh (CSB R) and left

Achilles tendon (CTS L). The latter three entheses also show indications of high physical stress of their counterparts on the left or, respectively, right side in females (Fig. 7.14). The right *M. gluteus medius* appears as highly stressed in the female population, but features last in the male sample. In males, however, we find the entheses for the left *M. iliopsoas* as well as *M. gluteus minimus* among their highest-ranking MMS (Fig. 7.13), pointing to slightly differential activity patterns for the LL between the two sexes.

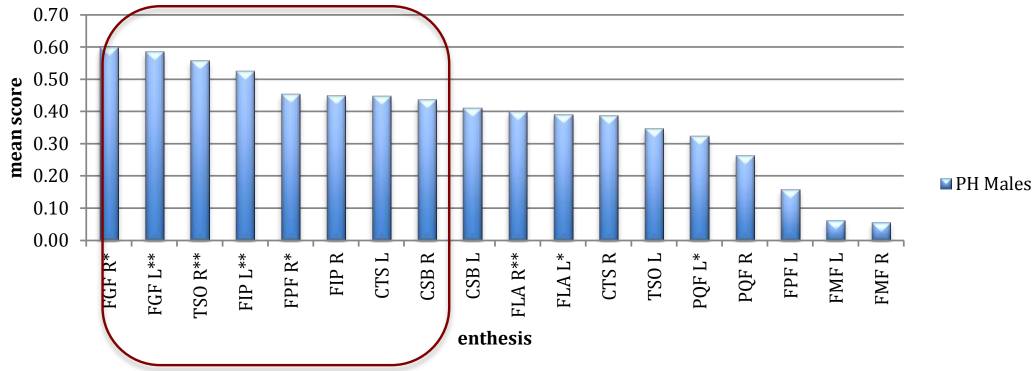


Fig. 7.13: Pleidelsheim - Rank ordering of MMS - Males, LL. */** indicate EC significantly higher than in F.

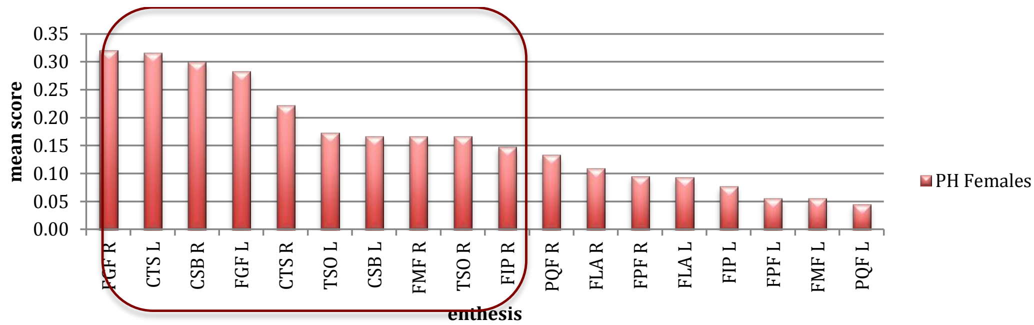


Fig. 7.14: Pleidelsheim - Rank ordering of MMS - Females, LL

7.1.2.2 Neresheim

a) Upper limb

In the male population at Neresheim, seven entheses of the UL fall among those showing the strongest changes (Fig. 7.15), and the rank order profiles reveal many similarities in muscle scores between males and females (Fig. 7.15 and Fig. 7.16; App. 7, Table 5). Although lower in rank as in the Pleidelsheim population, EC pointing to a high bilateral use of *M. biceps brachii* as well as *M. subscapularis* are observable for males and females. In addition to that, both sexes also share the right *M. pectoralis major* among their highest-ranking muscles, indicative of medial rotation and flexion of the right UL. In males, the left *M. pectoralis major*, with a significantly higher prevalence of EC than in the female sample from Neresheim (cf. Fig. 7.4), can also be observed among the highest-ranking muscles, while the left *M. pronator teres*, a forearm flexor and supinator, being significantly more highly scoring in males than in females, falls just outside the range if the highest scoring group of muscles (Fig. 7.15). Instead, changes are visible to the enthesis of the lateral extensors (HEL), but unlike in Pleidelsheim males, on the left rather than the right humerus. MMS of Neresheim females rank high for the left *Mm. supra- and infraspinatus*, with significantly higher stress onto this muscle group than found in males (Fig. 7.16).

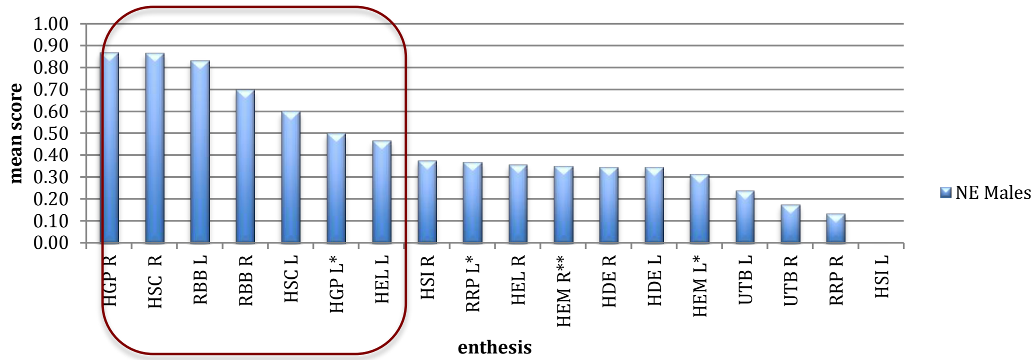


Fig. 7.15: Neresheim - Rank ordering of MMS - Males, UL. */** indicate EC significantly higher than in F.

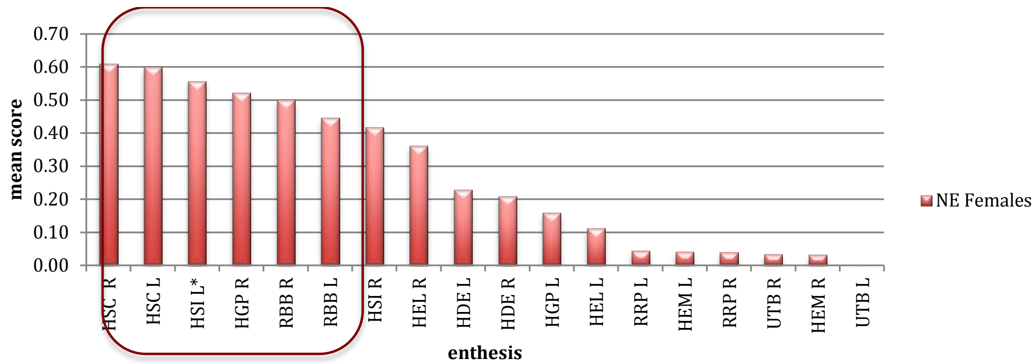


Fig. 7.16: Neresheim - Rank ordering of MMS - Females, UL. */** indicate EC significantly higher than in M.

b) Lower limb

The rank order profiles for the LL are similar for males and females at Neresheim (Fig. 7.17 and Fig. 7.18) with regard to high-ranking MMS for the left and right *M. gluteus maximus* and *Mm. triceps surae*, although EC of the latter scoring significantly higher in males (Fig. 7.17). The profiles diverge from each other with the males showing indications of significantly more stressed and high-ranking soleus muscles (TSO; Fig. 7.17), while the right *Mm. quadriceps femoris* as well as left *M. gluteus minimus* and hamstrings (CSB L) occur among the highest-ranking muscles among the females (Fig. 7.18). It is noteworthy, however, that compared to the MMS evident for *M. gluteus maximus* and the Achilles tendon, a noticeable drop in

MMS is visible with regard to the subsequent ranking muscles. Albeit observed as sexually dimorphic and distinctive for females (cf. Chapter 7.1.1.1, Fig. 7.6), the right *M. gluteus medius* does not fall among the highest scoring attachment sites in females but is rather found in the last position of the rank order profile (Fig. 7.18).

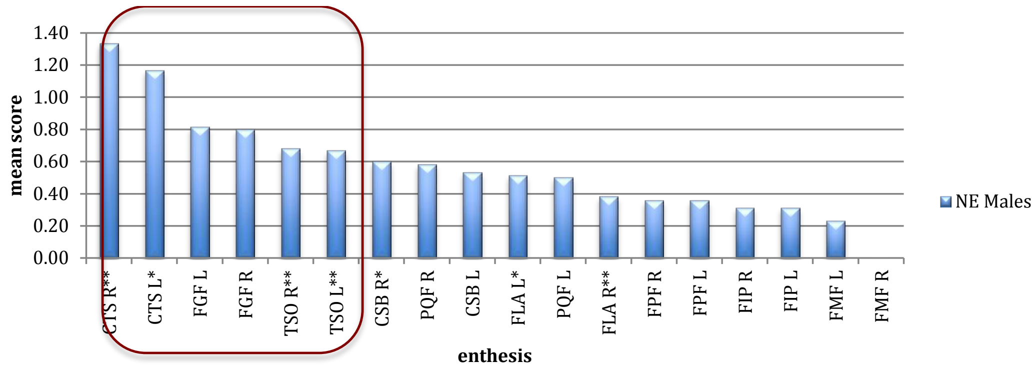


Fig. 7.17: Neresheim - Rank ordering of MMS - Males, LL. */** indicate EC significantly higher than in F.

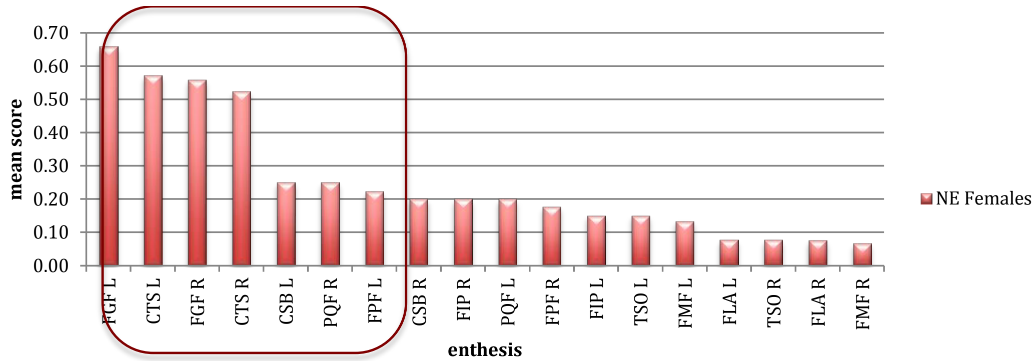


Fig. 7.18: Neresheim - Rank ordering of MMS - Females, LL

7.1.2.3 Inter-population comparison

Table 7.1 shows a comparative summary of the highest-ranking muscles in males and females from Pleidelsheim and Neresheim, divided into overall rank order (cf. App. 7, Tables 4 and 5) as well as into UL and LL as described above. While an overall comparison of highest scoring MMS provides a seemingly divergent picture, it is evident from a separate consideration of UL and LL that both populations not only share selected individual muscles among their highest scoring ones, but that both groups, males and females respectively from both cemeteries, also have divergent rank order profiles with regard to certain entheses, altogether pointing to differences in muscle use between populations as well as between sexes.

Table 7.1: Comparison of highest scoring enthesis in males and females at Pleidelsheim and Neresheim

PH M	PH F	NE M	NE F
Highest MMS - overall			
M. biceps brachii (RBB) R + L	M. biceps brachii (RBB) R + L	M. biceps brachii (RBB) L M. pectoralis major (HGP) R	M. pectoralis major (HGP) R
M. pectoralis major (HGP) R	M. subscapularis (HSC) R + L	M. subscapularis (HSC) R	M. subscapularis (HSC) R + L
M. gluteus maximus (FGF) R + L	Mm. supra- & infraspinatus (HSI) R + L	M. gluteus maximus (FGF) R + L	Mm. supra- & infraspinatus (HSI) L
M. soleus (TSO) R	Mm. triceps surae (CTS) L		M. gluteus maximus (FGF) L
M. iliopsoas (FIP) L		Mm. triceps surae (CTS) R + L	Mm. triceps surae (CTS) L
Highest MMS - Upper Limb			
M. biceps brachii (RBB) R + L	M. biceps brachii (RBB) R + L	M. biceps brachii (RBB) R + L	M. biceps brachii (RBB) R + L
M. pectoralis major (HGP) R + L	Mm. supra- & infraspinatus (HSI) R + L	M. pectoralis major (HGP) R + L	Mm. supra- & infraspinatus (HSI) L
M. subscapularis (HSC) R + L	M. subscapularis (HSC) R + L	M. subscapularis (HSC) R + L	M. subscapularis (HSC) R + L
Mm. lateral epicondyle (HEL) R		Mm. lateral epicondyle (HEL) L	M. pectoralis major (HGP) R
Highest MMS - Lower Limb			
M. gluteus maximus (FGF) R + L	M. gluteus maximus (FGF) R + L	M. gluteus maximus (FGF) R + L	M. gluteus maximus (FGF) R + L
M. gluteus minimus (FPF) R	M. gluteus medius (FMF) R		M. gluteus minimus (FPF) L
M. iliopsoas (FIP) R + L	M. iliopsoas (FIP) R		
M. soleus (TSO) R	M. soleus (TSO) L	M. soleus (TSO) R + L	Mm. quadriceps femoris (PQF) R
Mm. triceps surae (CTS) L	Mm. triceps surae (CTS) R + L	Mm. triceps surae (CTS) R + L	Mm. triceps surae (CTS) R + L
Mm. semimembranosus, semitendinosus & biceps femoris (CSB) L	Mm. semimembranosus, semitendinosus & biceps femoris (CSB) R + L		Mm. semimembranosus, semitendinosus & biceps femoris (CSB) L

a) Upper limb

M. biceps brachii and *M. subscapularis*, bilaterally, are ranked consistently high in all groups, indicating high scores of these muscles regardless of population or sex.

Males from both populations have high scores for the entheses of *M. pectoralis major* in common, as well as a high MMS rank order for the hand extensor muscles (HEL), set apart, however, by side: males at Pleidelsheim show EC to the right side insertion of the *Mm. lateral epicondyle*, males at Neresheim to the left, among the highest-ranking muscles. It has to be noted that the MMS for the right *Mm. lateral epicondyle* is identical for males in both populations (MMS = 0.36; App. 7, Tables 4 and 5), however, males from Neresheim show a markedly higher MMS in comparison for the left *Mm. lateral epicondyle* (cf. Fig. 7.7; App. 7, Tables 4 and 5).

Females from both populations share high scores for *Mm. supra- and infraspinatus*, although the MMS for the right enthesis of this muscle group falls just outside the group of highest-ranking muscles for females at Neresheim (Fig. 7.16). With *M. subscapularis*, this observation can be combined to define a potential functional group consisting of the rotator cuff muscles and indicating their intensified use, i.e. abduction and rotation of the arms, among females. In contrast to Pleidelsheim females, however, females at Neresheim exhibit high MMS for the right *M. pectoralis major*, pointing to intense flexion, adduction and rotation of the arms.

b) Lower limb

The consistently high score of EC for *M. gluteus maximus* as well as Mm. triceps surae (albeit only on the left side in Pleidelsheim males) indicates habitual strain on these muscles for all observed groups. Males at Pleidelsheim, however, exhibit a much more differentiated pattern of muscle involvement in the LL than males at Neresheim (Table 7.1) which may indicate more varied activity patterns for Pleidelsheim males. While the right *M. soleus* can be listed among the highest-ranking muscles for both male groups, Pleidelsheim males also show strong bilateral EC for *M. iliopsoas* and the left *Mm. semimembranosus, semitendinosus & biceps femoris*. Notably, increased scores for this muscle group can be found in all examined groups but one, i.e. males from Neresheim (Table 7.1).

While the rank ordering profile for females at Pleidelsheim, similarly to the males, includes the right *M. iliopsoas* and *M. soleus* (albeit on the left side), as well as, in addition to that, the right *M. gluteus medius*, among the list of highest-ranking muscles, we can observe a differing variation in the profile of Neresheim females. Indeed, their range of highest scoring muscles of the LL compares rather to that of *males* at Pleidelsheim (Table 7.1), with *M. gluteus minimus* (albeit of the left side) ranking comparatively high. Females at Neresheim form the only group in which the muscles of the anterior thigh (PQF R) feature among the most stressed muscles, the combination of their highest-ranking muscles suggesting an activity pattern that differs considerably from that of Pleidelsheim females.

Rank ordering of MMS also allows further examination of differential muscle use between the two populations (Eshed *et al.* 2004 ; Havelková *et al.* 2010). Fig. 7.19 and Fig. 7.20 show the polarity in rank ordering between groups from Pleidelsheim and from Neresheim, with those of positive value indicating higher and disparate rank ordering in the group from Pleidelsheim.

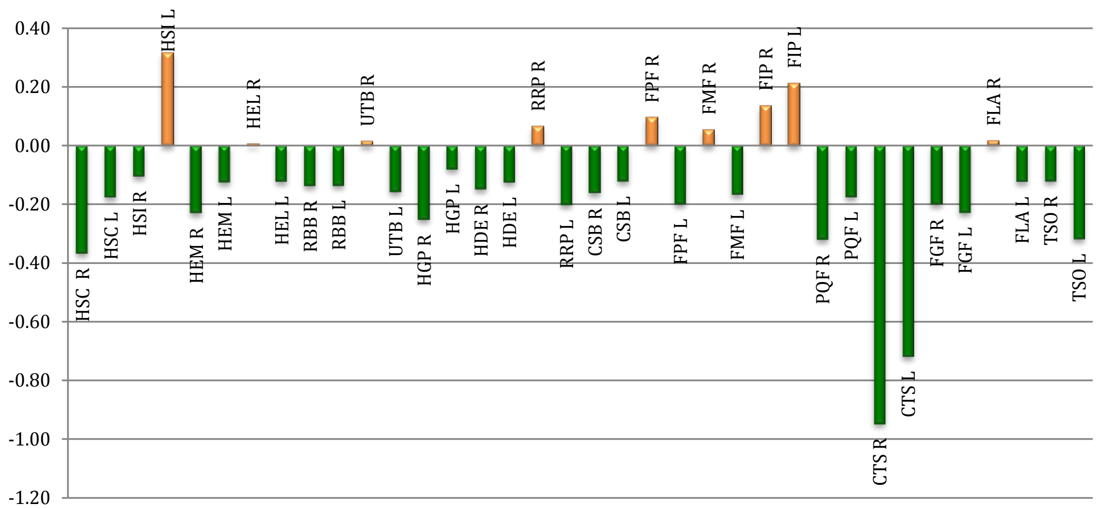


Fig. 7.19: Relative dimorphism between males at Pleidelsheim and Neresheim (expressed as absolute difference between MMS for every enthesis, in all males; muscles with a positive value have higher rank ordering in the male population of Pleidelsheim)

Except for the enthesis of the left *Mm. supra- and infraspinatus*, to which osseous changes seem to occur in males at Pleidelsheim, but not at Neresheim (cf. Fig. 7.7; App. 7, Table 3), as well as of the left *M. iliopsoas*, all attachment sites that demonstrate higher scores in Pleidelsheim males are located on the right side of the UL and LL (Fig. 7.19). The prevalence of the right *M. triceps brachii* is higher in the male population from Neresheim (cf. Fig. 7.7) but ranks distinctly higher in terms of utilisation in Pleidelsheim males. The left *M. pronator teres* stands out for its high score in males from Neresheim (cf. Table 7.1; Fig. 7.15), yet its right counterpart is subject to more stress in males from Pleidelsheim. Moreover, triceps and biceps are antagonists, promoting flexion and extension of the arm; thus, their combination as characteristic for Pleidelsheim males may suggest a potential functional link.

Regarding the LL, those entheses with distinctly higher rank ordering in Pleidelsheim males (Fig. 7.19) consistently show a higher, albeit not significantly different, prevalence in this group (cf. Fig. 7.8) and are now revealed as being higher ranked, i.e. definably more stressed, than those from Pleidelsheim.

Considering the female populations, relative dimorphism in rank ordering assumes a more varied pattern (Fig. 7.20). The extensor muscles attaching at the lateral epicondyle of the humerus, prominent on the right arm for Pleidelsheim individuals in the rank ordering profiles but only insignificantly more prevalent regarding the left side in Pleidelsheim females compared to those from Neresheim (cf. Fig. 7.9), appear as a more strongly affected muscle group in Pleidelsheim females. Changes to the left *M. triceps brachii* were already discerned as discrete occurrence in Pleidelsheim females (cf. Fig. 7.9), but EC to the right side also position this muscle distinctively high up in the ranking order for females at Pleidelsheim. The same applies to the deltoid muscles. The left *M. pectoralis major* appears to be more strongly affected in Pleidelsheim females, as opposed to the right pectoralis muscle, which ranks among the highest scoring muscles in Neresheim females (cf. Fig. 7.16). Overall, this UL pattern suggests movements involving flexion and extension particularly of the left arm that may have been undertaken more strenuously or frequently by females at Pleidelsheim.

The muscles of the right posterior thigh (CSB R) as well as *M. gluteus mediu*s rank higher and therefore show indications of higher physical stress in the females from Pleidelsheim, while those muscles responsible for the extension of the knee (FLA) as well as extension and medial rotation of the foot (TSO) not only showed higher prevalences in Pleidelsheim females before (cf. Fig. 7.10), but also emerge as distinctly different in their entheseal expression when compared to those of Neresheim females.

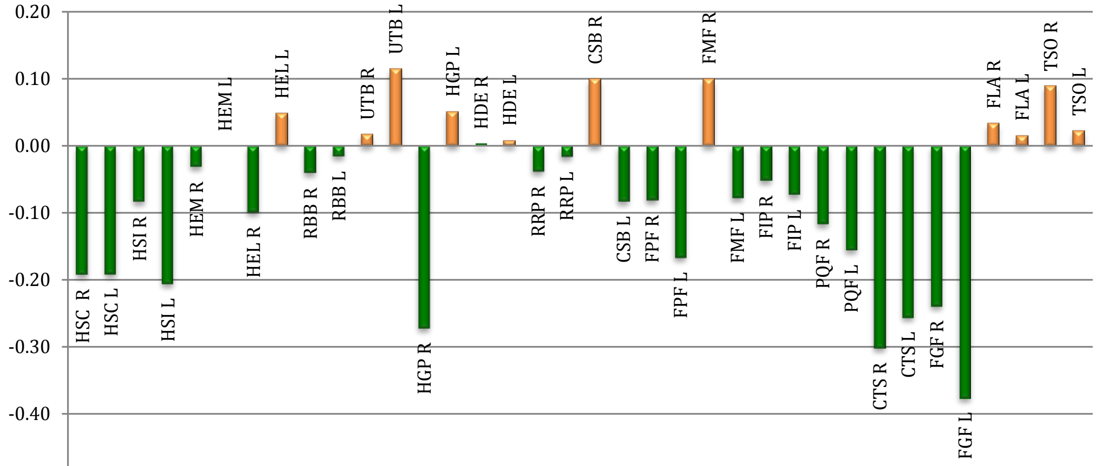


Fig. 7.20: Relative dimorphism between females at Pleidelsheim and Neresheim (expressed as absolute difference between MMS for every enthesis, in all females; muscles with a positive value have higher rank ordering in the female population of Pleidelsheim)

Overall, this comparison of rank ordering of the changes to muscular entheses reveals that while individuals at Neresheim may show higher prevalences of EC in the majority of cases (cf. Chapter 7.1.1.3), certain muscle attachments score more highly at Pleidelsheim, and the EC display differential patterns between the two populations. Despite notable similarities between the populations of Pleidelsheim and Neresheim, the extent of the changes to various entheses shows differing patterns among and between the populations and therefore indicates varying sex-linked differences between males and females at Pleidelsheim and Neresheim.

7.1.3 The influence of age on entheseal changes

7.1.3.1 Variability of habitual activity

The previous results have shown that at Pleidelsheim and Neresheim, males display a generally higher prevalence of EC than females, and individuals at Neresheim overall more signs of physiological stress than those at Pleidelsheim. The question is whether these differences between groups can be explained primarily by basic dimorphism, i.e. in case of male-female differences influenced by sexual dimorphism and underlying factors such as body mass and robusticity. In population comparisons, it may be that environmental factors indicate a population-level activity pattern, or differences pointing to more varied regimes of activity may eventually suggest variation of social groups (Robb 1998). This can be explored by quantifying the variability of EC within a group by determining the Index of Diversity *D*

$$D = 1 - \sum_{k}^{N} p_k^2$$

, with *k* being the number of categories scored (i.e. three: A, B and C) and *p* the proportion of all observable EC in any category scored for a group of skeletons. An index of 0 represents a lack of diversity (or variability), an index of 1 denotes a very high diversity, i.e. the higher the value, the greater the variability (Simpson 1949 ; Magurran 1988). While a certain degree of variability between the sexes or groups can be expected - due to sexual dimorphism, a higher amount of osseous changes in the LL as opposed to the UL as the effect of locomotion or greater body weight (Robb 1998), or the already established differences in the prevalence of EC between the groups -, greater diversity in a particular limb or in an entire group may indicate that individuals participated in more varied activity regimes.

Table 7.2 shows the Indices of Diversity for males and females at Pleidelsheim, with males demonstrating an average diversity of 0.45 for the UL and 0.61 for the LL, and females with an average diversity of 0.29 for the UL and 0.25 for the LL, respectively. This suggests that males at Pleidelsheim respond more exuberantly to EC. It may also indicate that they participated in a more varied regime of habitual activities than did females, or performed heavier or differing tasks, as they display a greater variation of EC, in every age category and overall, although the differences between males and females are not statistically significant for the UL or LL (using Mann-Whitney U-test, M*F UL: p = .513, LL: p = .127).

Table 7.2: Pleidelsheim - Index of Diversity in each age and sex category

Age Category	D	
	M	F
Upper Limb		
YA [16 – 25]	0.12	0.00
MA [26 – 45]	0.44	0.31
OA [46+]	0.78	0.55
average	0.45	0.29
Lower Limb		
YA [16 – 25]	0.29	0.15
MA [26 – 45]	0.59	0.28
OA [46+]	0.94	0.32
average	0.61	0.25

However, in males, the average of diversity is greater in the LL than in the UL, while in F, we can observe a trend towards the opposite, i.e. females at Pleidelsheim may have conducted slightly more varied habitual activities affecting the UL.

At Neresheim (Table 7.3), the index of variability in males is 0.63 in the UL and 0.67 LL, while females display 0.35 for the UL and 0.34 for the LL.

Table 7.3: Neresheim - Index of Diversity in each age and sex category

Age Category	D M	D F
Upper Limb		
YA [16 – 25]	0.42	0.16
MA [26 – 45]	0.50	0.38
OA [46+]	0.96	0.50
average	0.63	0.35
Lower Limb		
YA [16 – 25]	0.21	0.06
MA [26 – 45]	0.73	0.41
OA [46+]	1.07	0.56
average	0.67	0.34

Not unexpectedly, also at Neresheim, males demonstrate a greater average of diversity than females, regardless of age category, with the difference between males and females in the UL being notably greater than between the two sexes at Pleidelsheim, although also here, this difference was not found to be statistically significant (Mann-Whitney U-test, M*F UL: UL: p = .275, LL: p = .275). While no further indication for a possible social division of labour can be interpreted from these data, it is interesting that the addition of those males who could only be classified as 'adult', but not age-determined, would cause the index of diversity for the LL in males to rise to 1.00, a noticeably greater degree of variety pointing to a very different pattern of activity for males in Neresheim in comparison to the females.

The overall higher indices for individuals from Neresheim support previous findings by indicating that males and females at Neresheim participated in a more varied or strenuous regime of habitual activities than those at Pleidelsheim, although the differences for either UL or LL are not statistically significant for either group (Mann-Whitney U-test, M PH*NE UL: p = .513, LL: p = .827; F PH*NE UL: p = .827, LL: p = .513). In males, the LL shows similar indices, but regarding the UL, differences are discernible that indicate the development of greater entheseal alterations in males and may reflect more varied or strenuous tasks for them at Neresheim in any given age category. In females, there is a difference in average indices for both the UL and the LL. For the latter, this persists throughout life. Interestingly, the indices of the UL for females in middle and old adulthood are almost identical[104] (Table 7.2 and Table 7.3), whereas in young adulthood (YA), females at Pleidelsheim form the only group that displays no variability in activity-related changes in the UL.

Considering this analysis and its results, it is evident that the factor of age plays a significant role in the development and expression of EC and has to be taken into consideration when exploring differing patterns of activity-related changes within and between the two populations.

[104] Although in old adulthood, there may even be a tendency for females from Pleidelsheim to show a higher degree of diversity than females from Neresheim, however, larger sample sizes would be needed to confirm this phenomenon.

7.1.3.2 *Age and entheseal changes*

Fig. 7.21 demonstrates the influence of age on the prevalence of EC in males and females at Pleidelsheim and Neresheim.

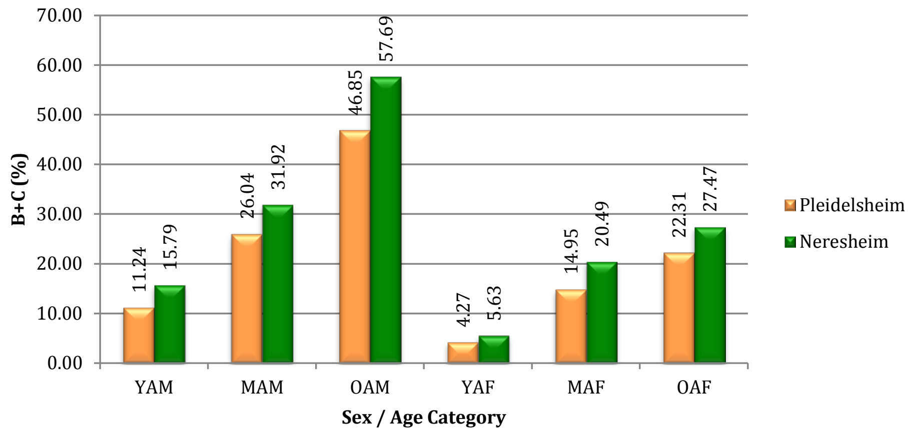


Fig. 7.21: Prevalence of entheseal changes in males (M) and females (F) according to age at Pleidelsheim and Neresheim

In both populations and sexes, the relationship between EC and age seems coherent: very little EC in YA, and a progressive increase of MSM scores from biological maturity through to old age, a correlation that follows the descriptions of multiple previous studies (Robb 1998 ; Wilczak 1998 ; Al-Oumaoui *et al.* 2004 ; Villotte *et al.* 2010) and appears to be due to a combination of mechanical stress and degenerative changes associated with advancing biological age. The correlation of all combined MSM scores with age, as displayed in Fig. 7.21, was not, however, found to be statistically significant for both sexes and both populations (Table 7.4).

Table 7.4: Correlation between age and prevalence of entheseal change in males and females at Pleidelsheim and Neresheim

	Total			Males			Females		
	n°	ρ [a)]	p - value	n°	ρ [a)]	p - value	n°	ρ [a)]	p - value
PH	178	.137	NS	88	.118	NS	90	.180	NS
NE	126	.092	NS	43	.177	NS	83	.048	NS

[a)] Spearman's rank correlation coefficient, with *p<0.05, **p<0.01

Throughout this study, EC were scored on a scale where

- A = absence of EC, i.e. observation of a healthy, unmodified enthesis
- B = (minor) entheseal change observable
- C = significant entheseal change present.[105]

While for the consideration of the presence of changes to the muscle attachment sites in males and females in the observed populations scores B and C could be considered jointly, a more differentiated analysis of the strength of EC can be more informative, especially with the consideration of age as an influence on EC. Fig. 7.22 and Fig. 7.23 show the distribution of MSM scores for males and females in Pleidelsheim and Neresheim. At Pleidelsheim (Fig. 7.22), males, as a whole, show EC in 30.9 % of observable cases, of which only 5.9 % attain the greatest severity score of the muscle attachment site (score C). In females, this fraction is even lower, with 1.8% of major EC out of an overall of 17.2% of osseous changes to the entheses.

[105] For details on this scoring system, cf. Chapter 4.2.1.7, "Materials and Methods".

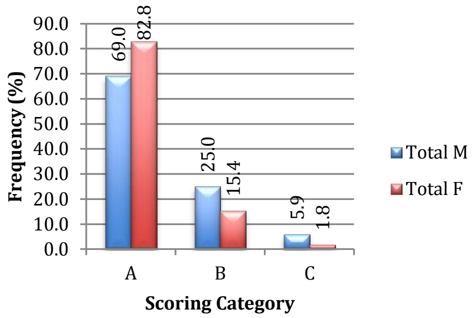


Fig. 7.22: Pleidelsheim - Frequencies of observations of absence (A), presence (B) and strong presence (C) of EC

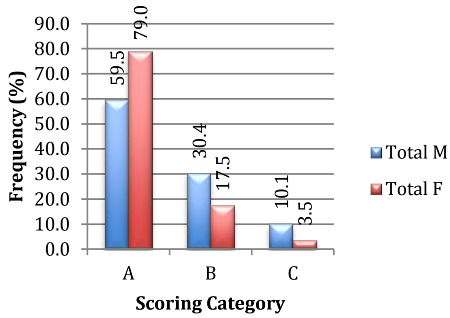


Fig. 7.23: Neresheim - Frequencies of observations of absence (A), presence (B) and strong presence (C) of EC

At Neresheim (Fig. 7.23), EC could be observed in 40.5% of all male individuals, of which 10.1% display major changes to muscle attachment sites. Also here, females show less EC (21%) than males, with only 3.5% of observations for the highest score (C), indicating severe entheseal changes.

When broken down into age categories, it becomes clear that the development for both minor and major EC presents the same positive trend for correlation with age (Fig. 7.24) as observed before (Fig. 7.21).

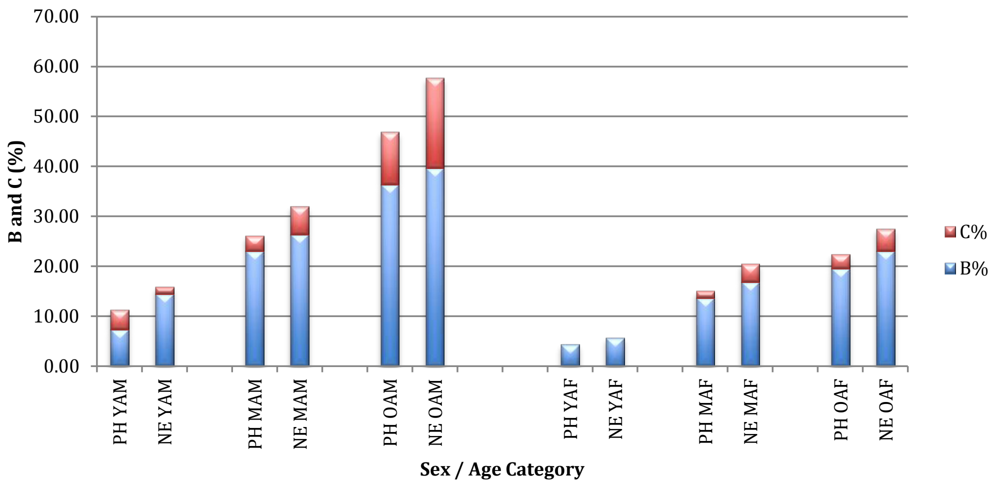


Fig. 7.24: Prevalence of B and C scores (minor and major entheseal changes) in males (M) and females (F) according to age at Pleidelsheim and Neresheim

However, it is notable that EC in males and females from Neresheim are not only more prevalent, but also comparatively more strongly expressed, as evidenced by a higher number of C scores. Furthermore, major EC in both sexes at Neresheim show a greater increase with advancing age than in males and females at Pleidelsheim, while compelling differences between as well as among the groups during young adulthood become visible.

a) Pleidelsheim

Fig. 7.25 and Fig. 7.26 present the frequencies of combined UL and LL MSM scores, divided into minor (scoring category B) and major (scoring category C) changes to muscular entheses, and provide a comparative overview of the occurrence of EC in each age category at Pleidelsheim.

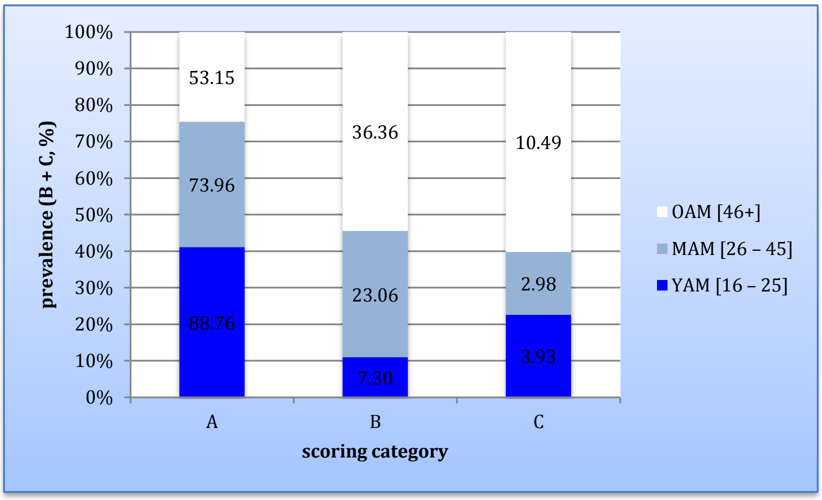


Fig. 7.25: Pleidelsheim - Frequencies of MSM scores in each scoring category and age group: Males (YAM = young adult males; MAM = middle adult males; OAM = old adult males)

As expected, males in young adulthood show the greatest absence of EC with regard to the total male population, followed by MA and OA, i.e. an increasing presence of EC with age (Fig. 7.25). OA males show the highest frequencies of both minor and major EC. However, more YA males show higher frequencies of high MSM scores than MA males at Pleidelsheim (MMS YAM = 3.93, MAM = 2.98; App. 7, Table 6), a disparity that does not occur in any of the other observed samples.

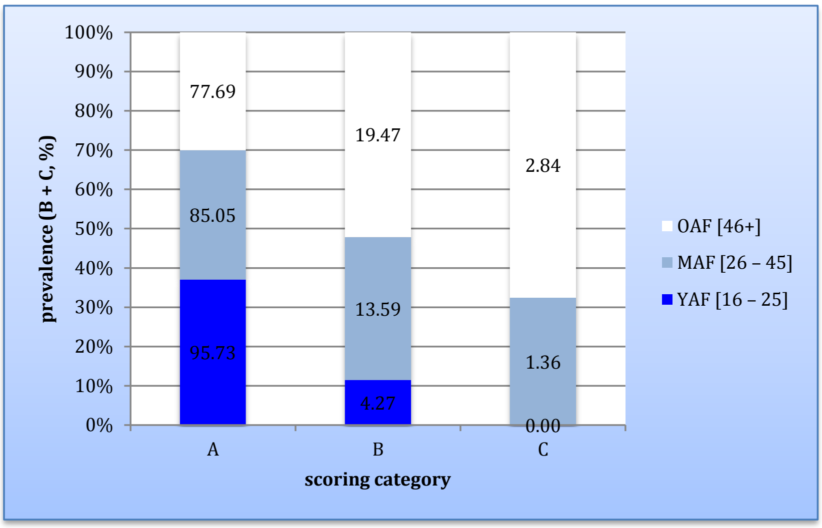


Fig. 7.26: Pleidelsheim - Frequencies of MSM scores in each scoring category and age group: Females (YAF = young adult females; MAF = middle adult females; OAF = old adult females)

In females (Fig. 7.26), major EC could only be observed from middle adulthood onwards (also cf. Fig. 7.24), although it has to be noted that the sample sizes for YA individuals are generally small (cf. App. 5, Tables 1 and 2). Generally, we can again observe higher frequencies of B and C scores with advancing age.

Fig. 7.27 and Fig. 7.28 present the changes in muscle markings with age separately for UL and LL in males and females at Pleidelsheim. With regard to the male population, the mean for UL MSM scores of major EC is almost equal in YAM (MMS = 2.53) and MAM (MMS = 2.99; Fig. 7.27; App. 7, Table 7). In the LL (Fig. 7.28; App. 7, Table 8), the mean score for YAM is 5.05, as opposed to 2.98 for MAM. Although the mean MSM score for changes to the UL entheses is noticeably high in YAM, a clear difference to MAM emerges in the changes to LL entheses.

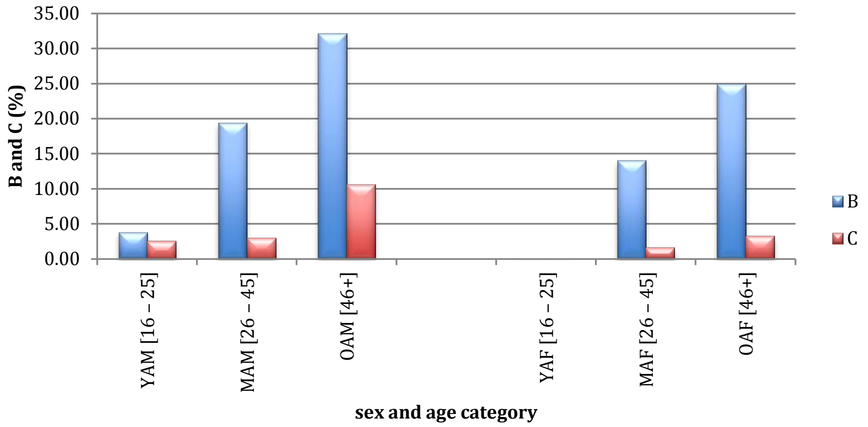


Fig. 7.27: Pleidelsheim - Changes in muscle markings with age: Upper Limb

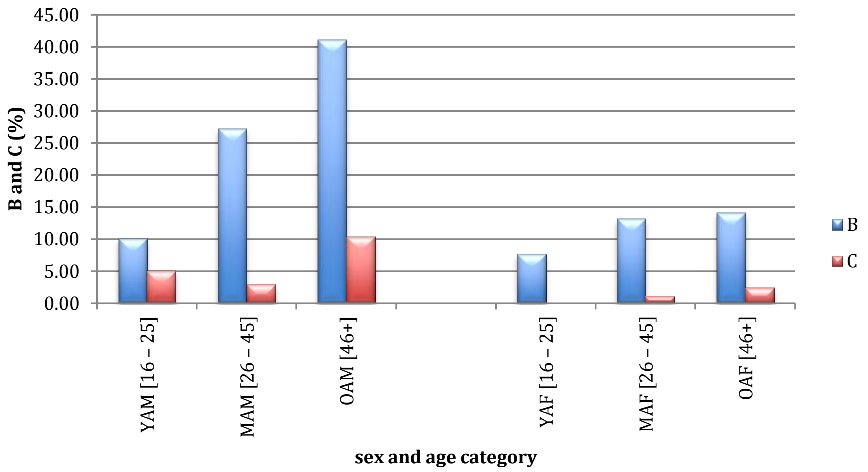


Fig. 7.28: Pleidelsheim - Changes in muscle markings with age: Lower Limb

The EC observed in the YA female population emerge as developing in the LL only (Fig. 7.28), while minor and major osseous changes to the UL entheses only start to show in individuals from middle adulthood onwards (Fig. 7.27). This complete absence of EC in young adulthood offers insight into the absence of variability noted before in the UL of YA females at Pleidelsheim (cf. Chapter 7.1.3.1, Table 7.2). Due to the observable patterns for EC in the UL primarily in females, the correlation with age is statistically significant for the EC in the UL, while for the LL, it remains non-significant regarding all UL and LL entheses in both males and females (Table 7.5).

Table 7.5: Correlation between age and prevalence of entheseal change: Pleidelsheim

Pleidelsheim	Total		Males		Females	
	n°	p - value [a)]	n°	p - value [a)]	n°	p - value [a)]
UL	178	.011**	88	NS	90	.055[(*)]
LL		NS		NS		NS

[a)] Spearman's rank correlation coefficient, with *p<0.05, **p<0.01

With regard to laterality (App. 7, Table 12), no statistical significant difference was found between MMS of right and left side, in either UL (Fig. 7.29) or LL (Fig. 7.30) for males and females at Pleidelsheim (t-test, p<0.05).

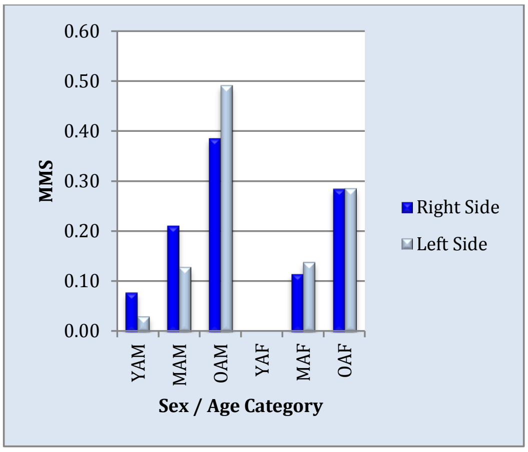


Fig. 7.29: Pleidelsheim - Comparison of MMS right and left in males and females: Upper Limb

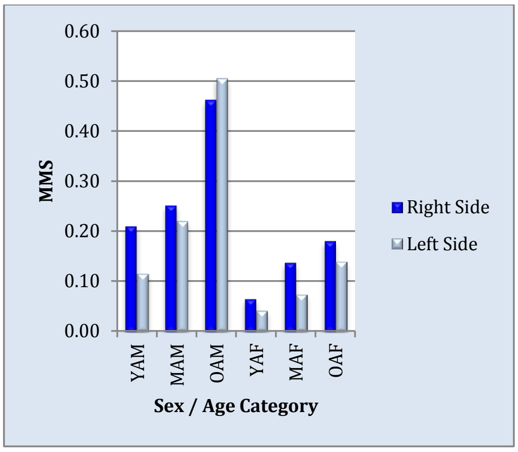


Fig. 7.30: Pleidelsheim - Comparison of MMS right and left in males and females: Lower Limb

It is noteworthy, however, that while in females and in the LL of both sexes the increase of EC with age is relatively constant for both sides - with the right side showing a generally higher prevalence of EC than the left side -, in males, there appears to be a marked right-side dominance in the UL, with EC increasing at a steady rate up to old age, while EC in the male left UL rapidly increase in prevalence only with old age (Fig. 7.29).

b) Neresheim

At Neresheim, the rates for EC with progressing age develop without notable peculiarities. In males (Fig. 7.31), the prevalence of minor ('B') and major ('C') EC increases towards old adulthood, with an onset of major EC that can be already observed in YA, but does not exceed that of MA or OA.

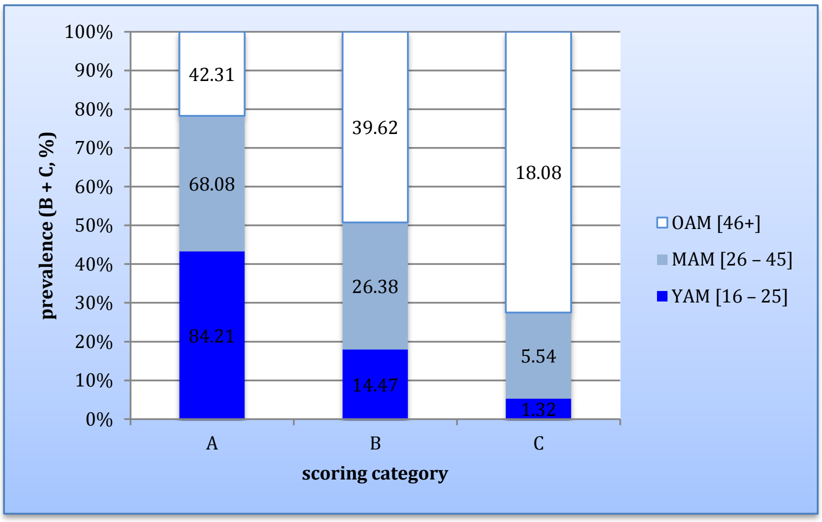


Fig. 7.31: Neresheim - Frequencies of MSM scores in each scoring category and age group: Males (YAM = young adult males; MAM = middle adult males; OAM = old adult males)

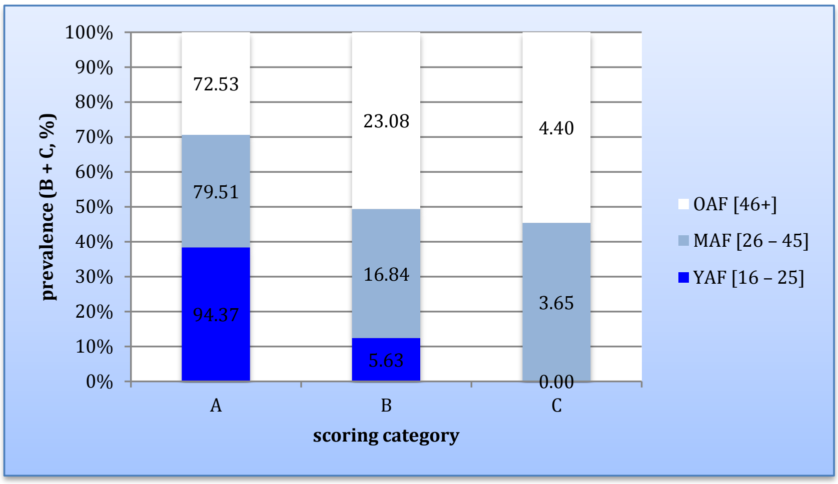


Fig. 7.32: Neresheim - Frequencies of MSM scores in each scoring category and age group: Females (YAF = young adult females; MAF = middle adult females; OAF = old adult females)

In females at Neresheim (Fig. 7.32), minor EC could be observed from young adulthood onwards (also cf. Fig. 7.24), while frequencies of higher MSM scores are only observable from middle adulthood onwards.

Examining the UL and LL separately (Fig. 7.33 and Fig. 7.34), the increase in frequency of osseous changes, whether minor or major, is evident in the UL entheses for both sexes (Fig. 7.33), with one exception: the MMS for females decreases slightly, from 4.18 in MA to 3.91 in OA (Fig. 7.33; App. 7, Table 10).

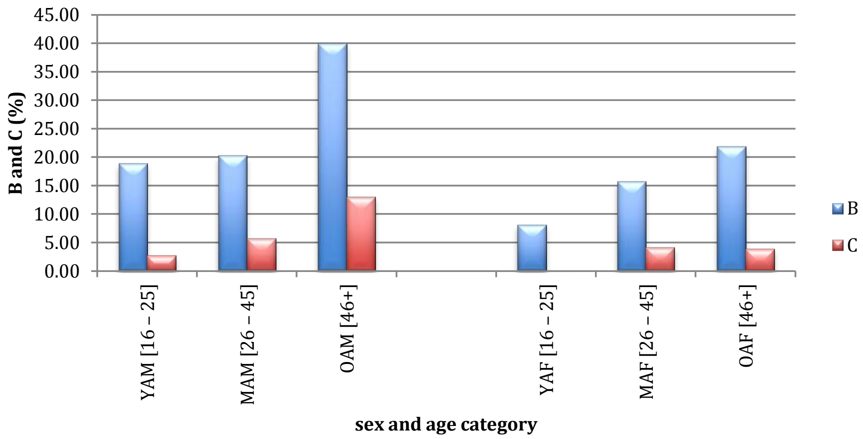


Fig. 7.33: Neresheim - Changes in muscle markings with age: Upper Limb

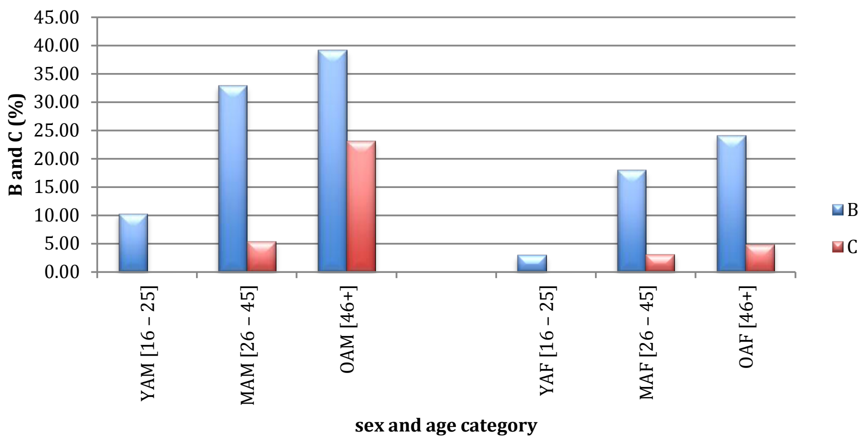


Fig. 7.34: Neresheim - Changes in muscle markings with age: Lower Limb

The absence of major EC in YA males may be due to the small sample size (only four individuals), so an interpretation of these results must remain cautious. However, the otherwise constant increase of EC of both types in males and females leads to a significant positive correlation of EC with age in the LL for the Neresheim population (Table 7.6).

Table 7.6: Correlation between age and prevalence of entheseal change: Neresheim

Neresheim	Total		Males		Females	
	n°	**p - value [a)]**	**n°**	**p - value [a)]**	**n°**	**p - value [a)]**
UL	126	NS	43	NS	83	NS
LL		.031*		NS		NS

[a)] Spearman's rank correlation coefficient, with *p<0.05, **p<0.01

Considering laterality (App. 7, Table 13), no statistical significant difference was found between MMS of right and left sides, in either UL (Fig. 7.35) or LL (Fig. 7.36) for males and females (t-test, p<0.05). However, the marked predominance of changes to entheses of the right side is obvious in the UL for both sexes throughout all age categories (Fig. 7.35), and notably different to the patterns found in individuals at Pleidelsheim (cf. Fig. 7.29).

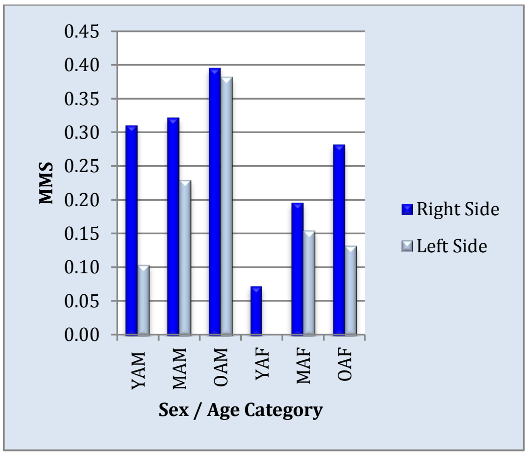


Fig. 7.35: Neresheim - Comparison of MMS right and left in males and females: Upper Limb

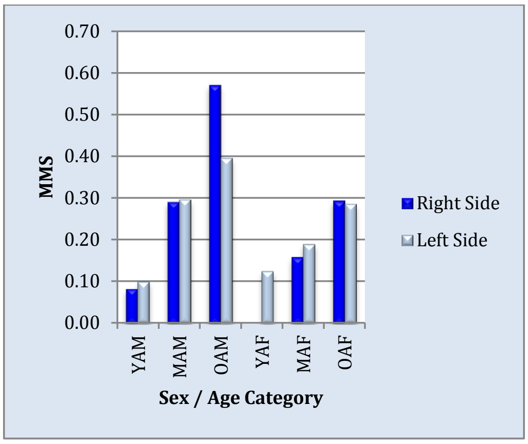


Fig. 7.36: Neresheim - Comparison of MMS right and left in males and females: Lower Limb

In the LL of males from Neresheim, the differences in laterality are lessened to a great degree, with a constant increase of EC on both sides throughout all age categories and only a more notable difference with a predominance of the right side during old adulthood (Fig. 7.36). Females do not seem to display any EC during young adulthood on the right side (Fig. 7.36), however this may be due to the nature of the small sample rather than a true reflection of conditions. The constant increase of EC in both sides with age is also visible for the female population.

7.1.3.3 The influence of age on individual entheses

As the preceding results demonstrate, changes to entheseal morphology are not solely associated with activity, but significantly with age. The analysis of morphological development of individual entheses with age, with regard to the sex-related patterns of EC already detected, will provide concluding information on differential muscle use between the sexes and populations.

a) Pleidelsheim

Males

In the male sample from Pleidelsheim, 15 out of 36 entheses show a significant positive correlation between age and EC, seven of which are found in the UL (Fig. 7.37), eight in the LL (Fig. 7.38).

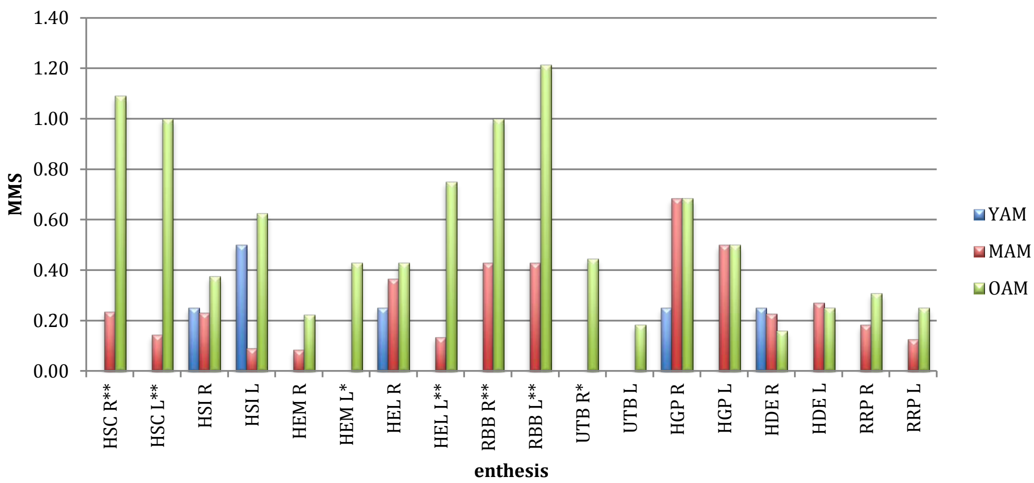


Fig. 7.37: Pleidelsheim - Relationship of MMS with age: Males, Upper Limb

In the UL (Fig. 7.37), a significant positive correlation with age (App. 7, Table 14) is found for

- *M. subscapularis* (bilaterally),
- flexor and extensor muscles of the left hand and fingers (HEM L, HEL L),
- *M. biceps brachii* (bilaterally),
- *M. triceps brachii* (right).

The onset of EC at middle adulthood for the insertions of *M. subscapularis* and their strong increase in old adulthood suggests the influence of degenerative changes to the development of changes to these entheses, not undermining the effects of increased habitual strain onto these muscles which effect the rotation of the arm, especially given they also occur among the highest ranking ones for Pleidelsheim males (cf. Table 7.1). Changes to the entheses of the flexor muscles at the medial epicondyle of the left humerus (HEM L) occur exclusively in old age in males from this group, while the attachment sites of their antagonists on the lateral epicondyle of the left humerus (HEL L) exhibit EC earlier, in middle adulthood. However, similar to the subscapularis muscles, they show a strong increase in EC during old adulthood. Albeit showing comparatively high prevalences for EC in middle adulthood, the same applies bilaterally to *M. biceps brachii*, muscles that also occur among the highest scoring ones among Pleidelsheim males (cf. Table 7.1), but do not show an onset for EC during young adulthood. The right (and left) *M. triceps brachii* entheses display EC exclusively in males within the OA category, similar to the aforementioned flexors of the left hand.

It is noteworthy that none of the muscles showing a strong positive correlation with age display EC in young adulthood (Fig. 7.37). Instead, EC observed at entheses of muscles responsible for abduction and lateral rotation of the arms (*Mm. supra- and infraspinatus*) suggest the earlier onset of changes at these muscles in young adulthood rather than in middle adulthood, especially on the left side, yet these muscle groups do not occur among the highest scoring UL muscles in Pleidelsheim males (cf. Table 7.1). The entheses of the extensor muscles attaching at the right lateral epicondyle (HEL R), which in turn are present among the highest-ranking male UL muscles (cf. Table 7.1) show a continuous increase of EC from young to old adulthood. Changes to the enthesis of the right *M. pectoralis major* can be observed during young adulthood, while the prevalence of EC during middle and old adulthood remains equally strong, similarly to the left *M. pectoralis* (Fig. 7.37; cf.

App. 7, Table 14). Not only does the right *M. pectoralis*, prime mover of arm flexion, therefore occur among the highest-ranking muscles for Pleidelsheim males and with significantly higher prevalence of EC than found in females (cf. Fig. 7.11), but changes to its enthesis also show an early onset. Finally, another muscle in the right arm, *M. deltoideus*, responsible for adduction and abduction, shows an inverse relationship with age in the male sample, albeit not statistically significantly so (App. 7, Table 14). The right deltoid muscle does not rank highly among entheseal alterations (cf. Fig. 7.11) and exhibits greater changes to its entheses in the female group (cf. Fig. 7.3), but it is the only muscle for which the highest prevalence of EC can be observed in YA males, as opposed to other age categories. Both *M. pectoralis major* and *M. deltoideus* have fibrous entheses; hence, caution is advised with regard to the meaning of EC at these muscle attachments. However, there is a marked appearance of patterns with regard to the right side of the UL for Pleidelsheim males that is noteworthy.

Finally, the previously observed similarity in the frequencies of major EC in males in young and middle adulthood (Fig. 7.27**)** could be explained by the age-related changes also apparent in the entheses of *Mm. supra- and infraspinatus* as well as right *M. deltoideus*.

With regard to the LL (Fig. 7.38), patterns emerging from the analysis of age-related EC are less varying regarding laterality, very likely due to the mechanical influences of locomotion controlling the LL.

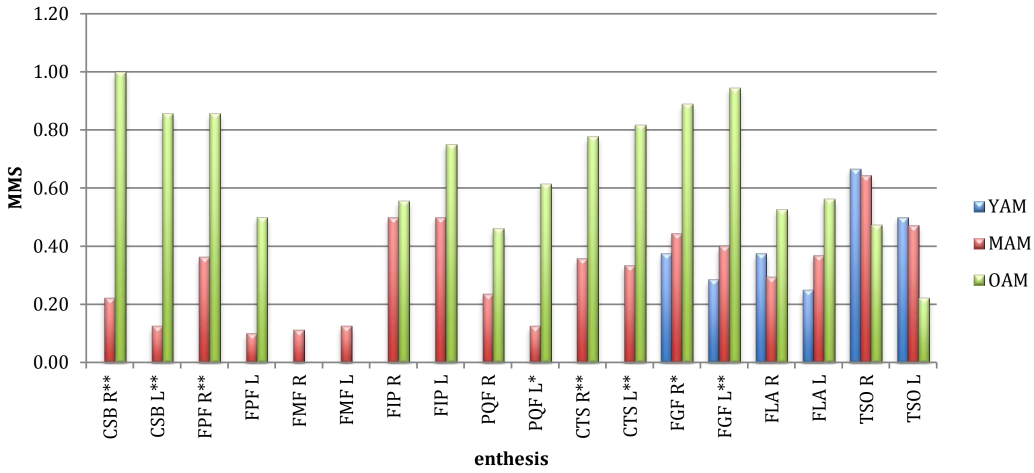


Fig. 7.38: Pleidelsheim - Relationship of MMS with age: Males, Lower Limb

With the exception of *M. soleus* (bilaterally), which shows an inverse relationship with age, i.e. the highest prevalence of EC during young adulthood and the lowest during old adulthood, of the muscle group of *Mm. vastus medialis, adductor magnus and longus* (FLA) on the right side, which exhibits a higher prevalence of EC during young adulthood than during middle adulthood, as well as of *M. gluteus medius*, for which EC could only be recorded in MA males, all EC progress significantly once old adulthood is reached (Fig. 7.38). These changes are indicative of degenerative influences on the development of EC in the LL. Almost all EC correlate positively with age, eight of them significantly so (App. 7, Table 14):

- *Mm. semimembranosus, semitendinosus and biceps femoris* (bilaterally),
- *Mm. quadriceps femoris* (right),
- Achilles tendon (CTS, bilaterally),
- *M. gluteus maximus* (bilaterally),
- *M. gluteus minimus* (right).

It should be noted that the onset of EC during young adulthood in this group is exclusively observed in fibrous entheses, demanding a cautious consideration of potential patterns for the LL[106]. However, YA males at Pleidelsheim show early signs of entheseal change, i.e. potentially habitual stress, bilaterally in the attachments for the hip adductors and leg extensors (FLA), *M. soleus*, as well as *M. gluteus maximus*, while changes to other muscles of the LL remain confined to the MA and OA categories (Fig. 7.38). Moreover, not only does *M. gluteus maximus* rank among the most highly scoring muscles among Pleidelsheim males (cf. Table 7.1), but changes to its enthesis appear to occur significantly more frequently than in Pleidelsheim females (cf. Fig. 7.2).

The notable difference in lower limb MMS between males in young and middle adulthood (Fig. 7.28) can potentially be ascribed to the age-related changes in the right *Mm. vastus and adductor* group (FLA R) as well as to the inverse relationship with age displayed in the entheses of *M. soleus*.

Females

Females at Pleidelsheim only demonstrate a statistically significant correlation of EC with age in the case of four entheses, all of which belong to muscles of the UL (App. 7, Table 15).

[106] Regarding inherent problems with the interpretation of fibrous entheses, see Chapter 3.3.2.

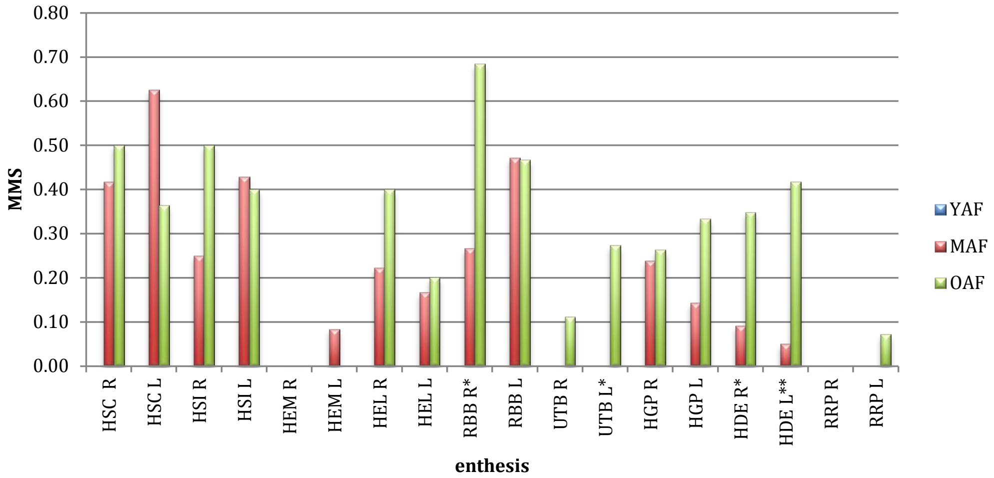


Fig. 7.39: Pleidelsheim - Relationship of MMS with age: Females, Upper Limb

As indicated before (cf. Fig. 7.27), there is a notable absence of entheseal changes during young adulthood among Pleidelsheim females in the UL (Fig. 7.39). Those entheses that show a significant positive correlation with age are:

- *M. biceps brachii* (right),
- *M. triceps brachii* (left),
- *M. deltoideus* (bilaterally).

Only one of these, *M. biceps brachii*, appears among the highest-ranking muscles for females at Pleidelsheim (cf. Table 7.1), with a steep increase from middle to old adulthood (Fig. 7.39), which suggests a combination of strong habitual use of this muscle with degenerative changes setting in with older age. The left *M. triceps brachii* as well as both deltoid muscles are among those muscles that seemed to have been most frequently or strenuously affected in females in this population (cf. Fig. 7.3). However, similarly to Pleidelsheim males (Fig. 7.37), changes to the entheses of *M. triceps brachii* only appear during old adulthood, while the prevalence of EC of the *M. deltoideus* attachments increases from middle to old adulthood, on the right side less markedly than on the left side of the body (Fig. 7.39), a reverse reflection of *M. deltoideus* patterns from middle adulthood onwards in the male population.

The only muscles whose entheses show a higher prevalence of changes during middle adulthood than with old age are those of the left *M. subscapularis* and *Mm. supra- and infraspinatus*, emphasizing high and frequent effects in the rotator cuff muscles already presented by the rank order profiles (cf. Fig. 7.12), placing them primarily into the MA category and suggesting a potential link to movement of the left UL. This is supported by the EC produced during middle adulthood by the left *M. biceps brachii*, which are found to be comparatively high among the UL sample and equal in prevalence to those of EC observed for OA females (Fig. 7.39; cf. App. 7, Table 15).

In the LL of Pleidelsheim females (Fig. 7.40), no individual muscle attachment shows a statistically significant correlation of EC with age (App. 7, Table 15), yet three LL entheses are observable that exhibit the onset of osseous changes during young adulthood (Fig. 7.40):

- *M. gluteus maximus* (right) and
- *M. soleus* (bilaterally).

The pattern visible for EC in the attachments for the soleus muscles does not follow an inverse relationship with age, as in the male population at Pleidelsheim, but displays a steep decline of EC from young to middle adulthood, only to show an increased prevalence again in OA females (Fig. 7.40). *M. gluteus maximus* is the only muscle that produced a constant increase of EC with advancing age at its enthesis in this sample, similar to the male population (Fig. 7.38). This is suggestive of a common frequent use of these muscles, yet with regard to previous observations (cf. Fig. 7.2), the severity of changes at those muscle attachments in males was significantly higher.

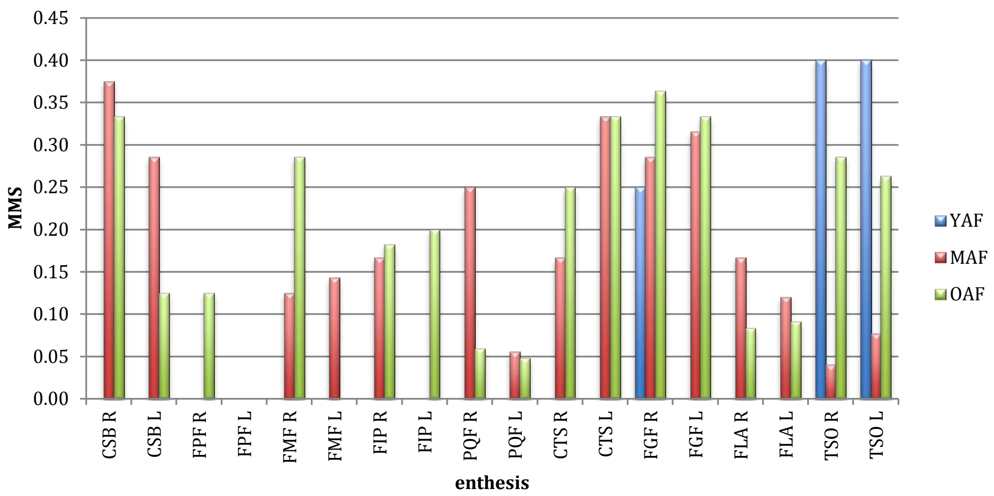


Fig. 7.40: Pleidelsheim - Relationship of MMS with age: Females, Lower Limb

The previously observable slightly varying increase in the prevalence of EC with age in Pleidelsheim females (cf. Fig. 7.28), in contrast to the more constant case in point for Pleidelsheim males, is elucidated when examining the patterns of osseous changes to individual entheses. It becomes evident that some entheses only show osseous changes with old adulthood, while others vary in their prevalence. Apart from the muscles of the posterior thigh (CSB), all those LL muscles occurring among the highest scoring ones in Pleidelsheim females (cf. Table 7.1) show the onset of EC in middle adulthood and increase with old age (Fig. 7.40). The entheses for hamstrings (CSB), but also for the right *Mm. quadriceps femoris*, seem to be particularly strongly expressed in MA females, with a subsequent decline with age, especially in case of the left side.

b) Neresheim

Males

In the male sample from Neresheim, eight out of 36 entheses show a significant positive correlation between age and EC, four in both the UL and LL (App. 7, Table 16).

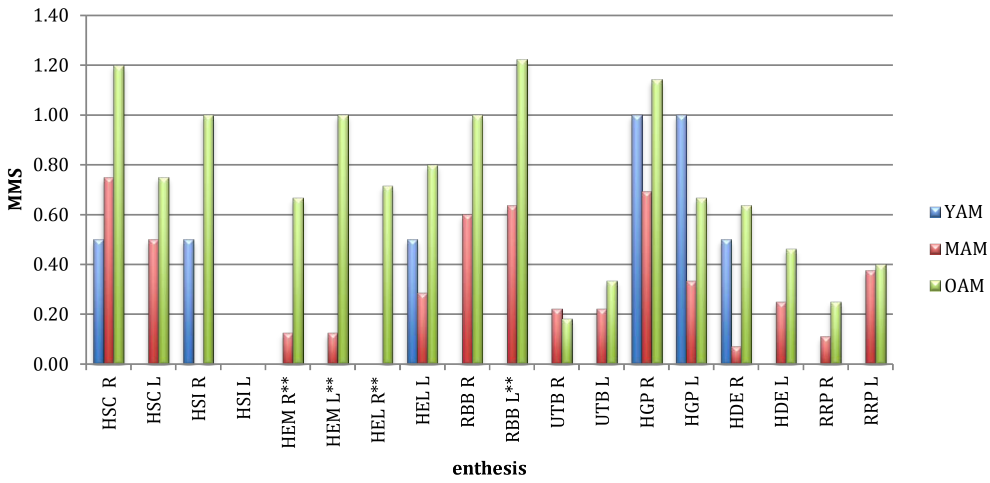


Fig. 7.41: Neresheim - Relationship of MMS with age: Males, Upper Limb

In the UL (Fig. 7.41), these are

- the flexor muscles (HEM) attaching at the medial epicondyle of the right and left humeri,
- the extensor muscles (HEL) attaching at the lateral epicondyle of the right humerus,
- the left *M. biceps brachii* attachment.

With regard to the osseous changes for the entheses of the muscles attaching to the medial epicondyle as well as those of the right lateral epicondyle, a very strong, if not exclusive prevalence is observable during old adulthood. The same pattern, albeit with comparatively higher prevalence of EC during middle adulthood, is evident in the changes to the *M. biceps brachii* entheses (Fig. 7.41). As all of these entheses, with the exception of the right extensor muscles (HEL R), also occur among the highest-ranking muscles for Neresheim males (cf. Table 7.1), as well as represent those which show significantly higher prevalences in males than in females in this population (cf. Fig. 7.4), the influence of degenerative changes onto the entheses of frequently highly stressed muscles is manifest.

As in the male group from Pleidelsheim (Fig. 7.37), none of the entheses showing an early onset of changes, i.e. during young adulthood, display a significant positive correlation with age (Fig. 7.41). However, four entheses for muscles that also rank among the most highly scoring ones (cf. Table 7.1) exhibit EC in YA males (Fig. 7.41). The right *M. subscapularis* shows a constant increase of EC with age, while changes to the entheses of the left *M. subscapularis* can only be observed from middle adulthood onwards. The right *Mm. supra- and infraspinatus* follow a similar pattern, albeit no EC could be detected in MA males in this sample, which also presented a complete absence of EC to the left *Mm. supra- and infraspinatus* (Fig. 7.41), in contrast to patterns found in YA males at Pleidelsheim (Fig. 7.37). The left extensor muscles (HEL L) seem to have been especially affected in the male population from Neresheim, given that they occur among their highest-ranking muscles (cf. Table 7.1) and show a markedly higher MMS for this enthesis than that observed in Pleidelsheim males (cf. Fig. 7.7; App. 7, Tables 14 and 16). Bilaterally, the pectoralis muscles, generating adduction, flexion and medial rotation of the arm, show the highest MMS (1.00; App. 7, Table 16) within the YA category, with a subsequent decline in the prevalence of EC during middle adulthood and another increase with old adulthood. To this, the right *M. deltoideus* can be added, with MMS of 0.50 (YA) and 0.67 (OA) as opposed to only 0.07 for MA males (App. 7, Table 16; Fig. 7.41), although this muscle does not rank highly in the sequence of most frequently affected muscles (cf. Fig. 7.15), nor is it differently affected when compared with the same attachment in Pleidelsheim males (cf. Fig. 7.19). Although the fibrous nature of the entheses for *M. pectoralis major* and *M. deltoideus* demands reservation with regard to the construal of possible functional patterns appearing already at YA age, the concentration of EC during young adulthood in entheses of the right UL is notable, as is the shared significance of the early onset of EC noted in the right *M. deltoideus* in Pleidelsheim and Neresheim males, a muscle that does not occur as a particularly highly-ranking one in either population, nor does it show a significant correlation with age.

In Neresheim males, a relatively constant prevalence of EC can be seen in the LL with advancing age (Fig. 7.42), supported by the statistically significant correlation found earlier for the entirety of LL entheses (cf. Table 7.6). A positive relationship with age can be traced in all but four entheses (Fig. 7.42): the fibrocartilagenous enthesis of the right *M. gluteus minimus* shows an early onset of EC in the YA category, with a slight decline during middle adulthood and an increase with old age. The entheses for *Mm. triceps surae*, providing MMS scores that place these muscles among the most highly scoring ones (cf. Table 7.1), as well as being significantly more highly scoring in Neresheim males as compared to the same group in Pleidelsheim (cf. Fig. 7.8), present a higher prevalence of EC in middle adulthood than in the older age group. The left *M. soleus* attachment shows the highest prevalence of osseous changes in MA males, despite a constant increase with age in the case of its right counterpart (Fig. 7.42). The correlation with age is significant in the case of four entheses (App. 7, Table 16),

- *M. gluteus medius* (left),
- *M. gluteus minimus* (right),
- *M. gluteus maximus* (bilaterally).

This may signify a particularly susceptible group, evincing degenerative changes, which is slightly different from that found in Pleidelsheim males (cf. Fig. 7.38), as only the gluteal muscles are affected in the Neresheim group.

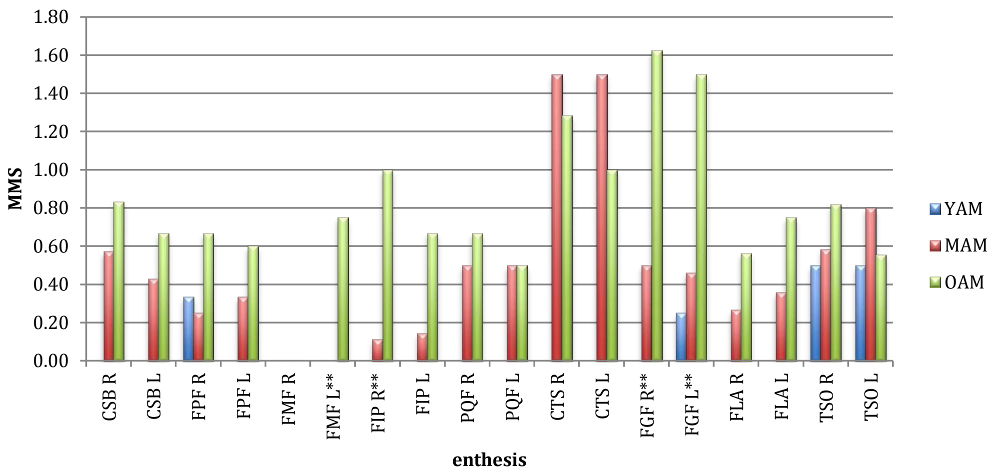


Fig. 7.42: Neresheim - Relationship of MMS with age: Males, Lower Limb

A further notable difference in the male group from Neresheim is that the onset of EC in the LL during young adulthood is distributed less markedly bilaterally than is the case at Pleidelsheim. Signs of early onset of EC in Neresheim males are found in the entheses of the right *M. gluteus minimus*, left *M. gluteus maximus*, as well as bilaterally of the *M. soleus* (Fig. 7.42), the latter two falling among the category of most highly scoring muscles in this group (cf. Table 7.1), while *M. gluteus minimus* ranks comparatively low among the MMS for the LL (cf. Fig. 7.17; App. 7, Table 5).

Females

Females from Neresheim show no significant correlation of EC with age for any enthesis of the UL (App. 7, Table 17), and in fact, only six UL entheses show an increase in the prevalence of entheseal modification with advancing age (Fig. 7.43).

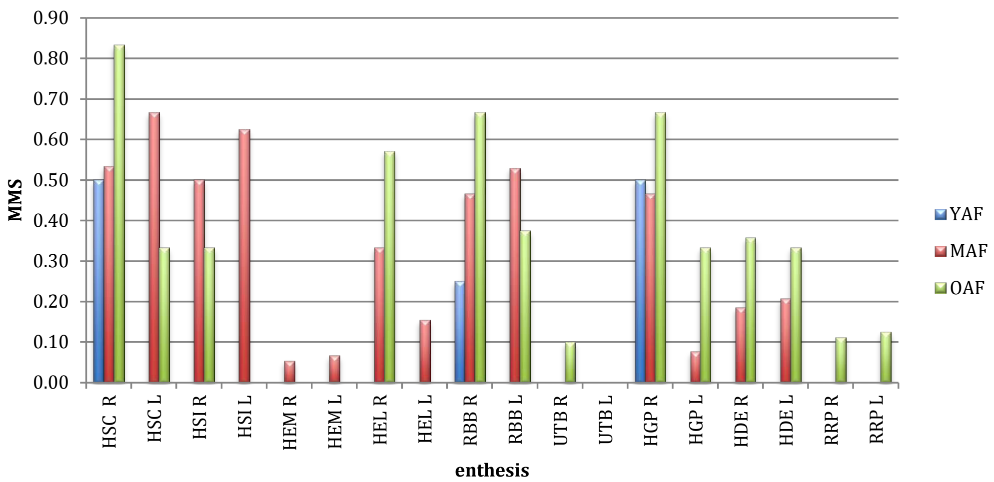


Fig. 7.43: Neresheim - Relationship of MMS with age: Females, Upper Limb

Among those are the entheses of the right *M. subscapularis*, the muscles of the lateral epicondyle, *M. biceps brachii*, *M. deltoideus* and *M. pectoralis major* as well as the left counterparts of the two latter, although the left pectoralis muscle shows a slight drop in MMS during middle adulthood (Fig. 7.43). Three of these entheses display an early onset: the right *M. subscapularis* (almost identical in the pattern of EC as in Neresheim males), *M. biceps brachii* and *M. pectoralis major*, all included in the range of highest-ranking muscles for Neresheim females (cf. Table 7.1), all on the right side of the UL, and all increasing with age, suggesting a definable pattern of effects for the females in the population.

The rotator cuff muscles (HSC and HSI) seem to largely correspond with patterns observed for Pleidelsheim females, and show a clear peak of EC during middle adulthood, prominent in particular in the MMS for *Mm. supra- and infraspinatus*

(Fig. 7.43). EC in the flexors (bilaterally) and left hand extensors are exclusively observable in MA females (Fig. 7.43), with a MMS for the left hand flexor muscles equal to those found in Pleidelsheim females (cf. App. 7, Tables 15 and 17). Also the left *M. biceps brachii*, found among the most highly scoring muscles (cf. Table 7.1), shows the highest prevalence of EC during middle adulthood, equipollent with the detectable onset of physical stress to its enthesis (Fig. 7.43).

As opposed to Pleidelsheim (cf. Fig. 7.39), females in the Neresheim population do not demonstrate observable changes of the enthesis of the left *M. triceps brachii*. Instead, they show evidence for increased expression during old adulthood of the enthesis of the right *M. pronator teres*, one of the two major forearm pronators and antagonist to the forearm extending M. triceps brachii, whose right enthesis also displays osseous changes in OA females (Fig. 7.43). This is the reverse reflection of patterns traced in Pleidelsheim females (i.e. a combination of left *M. triceps brachii* and *M. pronator teres*); yet since both entheses are found at the lower end of the rank order profile (Fig. 7.12; Fig. 7.16), changes here, especially as only occurring at old age, may be associated with age rather than with habitual utilization of these muscles.

Although almost all entheses of the LL in Neresheim females show an increase in osseous changes with age - with the exception of the left *Mm. quadriceps femoris*, *M. gluteus minimus* (bilaterally) and the right *M. soleus* (changes to the latter two in the right LL are only observed in MA females; Fig. 7.44) -, only one muscle group, the left *Mm. vastus medialis, adductor magnus and longus*, shows a significant correlation with age (App. 7, Table 17).

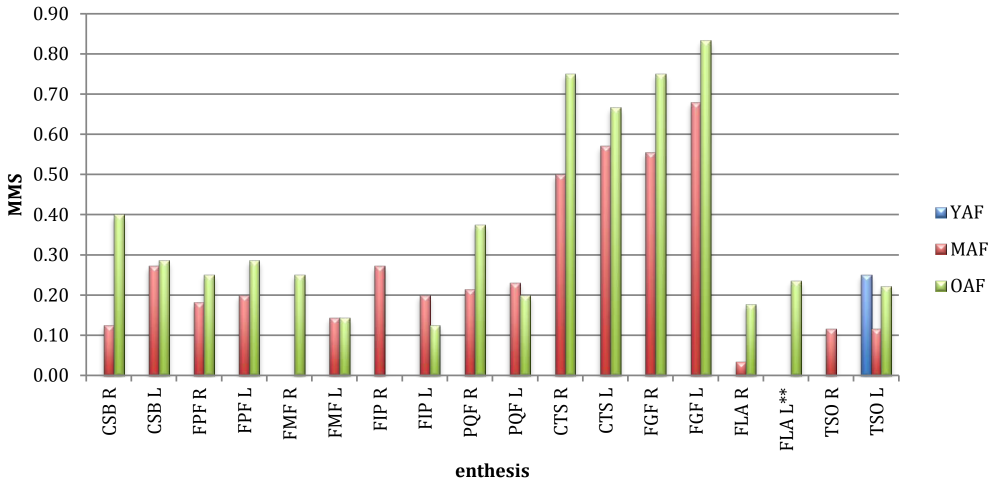


Fig. 7.44: Neresheim - Relationship of MMS with age: Females, Lower Limb

Apart from the left *M. gluteus minimus* and its decrease in the emergence of EC with advancing age, all muscles that rank among the highest scoring ones among Neresheim females (i.e. *M. gluteus maximus*, right *Mm. quadriceps femoris*, *Mm. triceps surae* and left hamstrings, cf. Table 7.1) show an increase of EC with age (Fig. 7.44). Curiously, EC of the soleus muscles remain comparatively low, do not occur among the highest-ranking muscles for Neresheim females and are only traceable during middle adulthood in case of the right enthesis. However, the left enthesis for this muscle does present the only case in this group where changes at young adulthood could be observed, with the highest MMS recorded for the left *M. soleus* across all age categories (Fig. 7.44; App. 7, Table 17).

Overall, the female profile of the distribution of EC in individual LL entheses with age does most closely resemble that of Pleidelsheim males (cf. Fig. 7.38), aside from the changes apparent in the hip adductors and leg extensors (FLA) as well as in *M. soleus*, rather than that of Neresheim males or Pleidelsheim females. This is an interesting finding that had also been observed in the comparison of the groups of highest-ranking muscles but becomes even more perceptible in the breakdown of individual entheses.

It is possible to trace varying patterns of physical effects and potentially differing patterns of activity or workload over life particularly in the UL among and between groups. Based on the observations of differential expressions of EC in males and females across the age groups, it is conceivable that we have not only observed indications for differences in habitual activity between males and females as well as populations, but are also able to witness particular activity patterns during young adulthood and their changes or continuation with advancing age. Table 7.7 presents a summary of the principal patterns observed in skeletal populations from Pleidelsheim and Neresheim and highlights the major outcomes of this analysis, with those particularly highly scoring muscles of the UL marked in yellow that were revealed as distinctive to individual groups. Moreover, it presents an attempt to accentuate potential differences as well as similarities in pattern of EC during different stages of life for males and females, possibly pointing to common activity patterns and their changes in either of the groups.

Table 7.7: Summary of entheseal changes as observed in individuals from Pleidelsheim and Neresheim

PH - Males		*PH - Females*		*NE - Males*		*NE - Females*	
UL	**LL**	**UL**	**LL**	**UL**	**LL**	**UL**	**LL**
Highest-ranking muscles							
RBB R + L HGP R + L HSC R + L HEL R	FGF R + L FPF R FIP R + L TSO R CTS L CSB L	RBB R + L HSI R + L HSC R + L	FGF R + L FMF R FIP R TSO L CTS R + L CSB R + L	RBB R + L HGP R + L HSC R + L HEL L	FGF R + L TSO R + L CTS R + L	RBB R + L HSI L HSC R + L HGP R	FGF R + L FPF L PQF R CTS R + L CSB L
Sexually dimorphic muscles (= greater stress found in females)							
		HSI R + L UTB L HDE R + L	**FMF R**			**HSI R + L**	**FMF R**
Significant correlation with age*							
**7 entheses*	**8 entheses*	**4 entheses*	**0 entheses*	**4 entheses*	**4 entheses*	**0 entheses*	**1 enthesis*
HSC R + L **HEM L** HEL L **RBB** R + **L** UTB R	CSB R + L FPF R PQF L CTS R + L FGF R + L	RBB R UTB L HDE R + L	-	**HEM** R + **L** HEL R **RBB L**	FMF L FIP L FGF R + L	-	FLA L
EC occurring during young adulthood							
HSI R + L HEL R **HGP R** **HDE R**	**FGF** R + L FLA R + L **TSO R + L**	-	FGF R **TSO** R + **L**	**HSC R** **HSI R** HEL L **HGP R** + L **HDE R**	FPF R FGF **L** **TSO R + L**	**HSC R** **HGP R** RBB R	**TSO L**
EC occurring MAINLY during middle adulthood **(_ = ONLY occurring during middle adulthood)**							
[HGP R + L] HDE L	**FMF** R + **L**	**HSC L** **HSI L** **HEM L** **[RBB L]**	CSB R + L **FMF L** **PQF** R **[+L]** [CTS L] FLA R + L	UTB R	[PQF L] CTS R + L TSO L	**HSC L** **HSI** R + **L** **HEM** R + **L** HEL L **RBB L**	**[FMF L]** FIP R + L **PQF L** TSO R
EC occurring ONLY during old adulthood							
UTB R + L HEM L	-	**UTB R** + L **RRP L**	FPF R FIP L	HEL R	FMF L	**UTB R** **RRP** R + **L**	FMF R FLA R
Higher prevalence / Differential utilization Pleidelsheim : Neresheim							
HSI L **UTB R** RRP R	FPF R **FMF R** FIP R + L **FLA R**	HEL L **UTB** R + L HGP L HDE L	CSB R **FMF R** **FLA R** + L TSO R + L		CTS R + L		FGF L

For key to codes see Plate A (App.). Codes marked in **bold** = entheses occurring analogous among groups. Codes marked in yellow = distinctive to particular group.

Considering previous results revealing higher prevalence and increased severity in general in males and, more broadly, in the individuals at Neresheim, as well as differing patterns between men and women in the two populations, it is evident from the present data that there is a slightly greater degree of sexual dimorphism present in the Pleidelsheim than in the Neresheim population, and that the highest correlation of EC with age is found in males, more precisely in those from Pleidelsheim. With regard to possible sex- and age-related patterns discernible from the analysis of UL entheses, it is distinctly clear how in every group in which changes to muscle attachments could be observed in individuals of the YA category, most of these muscles would also appear among the highest-ranking muscles overall. However, in observations of EC occurring during young adulthood in the male UL, the additional appearance of muscles belonging to the rotator cuffs, as well as of the right *M. deltoideus* (Table 7.7), are suggestive of distinctive activity patterns during young adulthood, which potentially extend into other age categories but are then moderated by age-related changes to the muscular entheses.

A greater number and more severe EC can be observed during young adulthood in the males than in the females in both populations. With no sign of early onset or variable pattern of EC in young Pleidelsheim females, these females contrast with those from Neresheim, who exhibit evidence of early onset of EC, potentially physical stress related to activity. In the female UL, patterns are most evident when comparing EC mostly or exclusively occurring in the MA category: their great similarity (with a few more muscles added in the group of Neresheim females) highlights a pattern of EC distinctly different to that of males and, possibly, of younger females, and common to females at later stages in life, as observed in both populations. This was already indicated by the similarity regarding the Index of Diversity (cf. Chapter 7.1.3.1) and suggests a difference between the two populations regarding female manifestations occurring in young adulthood that disappears with advancing age, although the data provide sufficient, though not statistically significant evidence for potential varying patterns of activity or a more extensive range of tasks conducted frequently by females at Neresheim.

EC occurring during old adulthood cannot be considered for defining any activity-related patterns, due to the uncertainty of mechanical and age-related coaction of biological influences onto the entheses in older individuals. However, the recording of EC observed *solely* in OA individuals reflects the presence of EC caused by sets of muscles (notably mostly of fibrocartilagenous character) which seem not to have featured significantly in younger age groups and are shared by all groups but one (Neresheim males; Table 7.7).

As the LL is more prone to external influences such as locomotion or differences in, for instance, terrain, a similar analysis would prove considerably less coherent, but the varying patterns of changes in the LL among males and females at Pleidelsheim and Neresheim are discernible.

7.2 Physical activity and material culture

The first part of this chapter explored the prevalence of EC within and among the populations of Pleidelsheim and Neresheim and revealed that it is possible to discern varying patterns of entheseal alteration indicated by the osseous changes to the muscle attachments. In light of these results, the following questions remain to be investigated:

- Does the occurrence of EC vary to a significant degree in individuals buried in different types of burial ('simple' grave, coffin, chamber grave)?
- Do individuals buried with GG show, in any given age category, significantly more or less EC than those individuals buried without any GG?
- Are there correlations between grave inclusions and EC?

In the great majority of cases, individuals in Pleidelsheim and Neresheim were not buried with grave inclusions that would point to a specific activity in life. Aside from items of weaponry, which may or may not relate to active use by the people buried with them, as well as items of textile manufacturing (spindle whorls and weaving swords), burial accoutrements do not seem to have reflected particular activities, habitual or recently acquired, of the deceased. Therefore, a general comparison of patterns of muscle use in identified 'burial groups' (Chapter 6) imparts a novel insight to the distinctions already observed regarding burial goods and skeletal indicators.

Where the consideration of GG is involved in this analysis, only intact burials were considered. Tests were conducted for males and females divided by UL and LL, given the detected similarities and differences in EC.

7.2.1 Entheseal changes in varying burial groups

7.2.1.1 MSM and burial types at Pleidelsheim and Neresheim

a) Upper limb

Fig. 7.45 and Fig. 7.46 show the prevalence of minor (score B) and major (score C) EC in the UL of males buried in coffins (type A), 'simple' graves (type B) and grave chambers (type C) at Pleidelsheim and Neresheim.

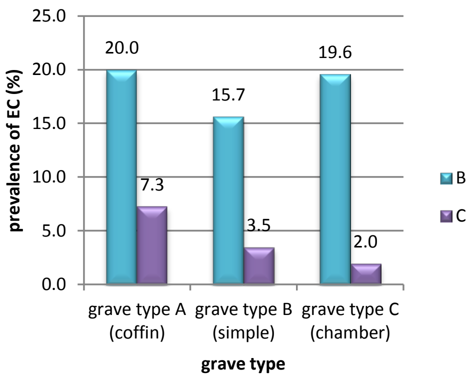


Fig. 7.45: Distribution of muscle scores in various grave types: Pleidelsheim - Males, UL

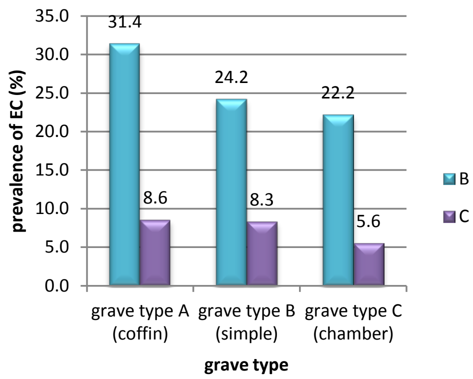


Fig. 7.46: Distribution of muscle scores in various grave types: Neresheim - Males, UL

At Neresheim, the highest prevalence of UL EC is observable in those males buried in coffins, the lowest in those interred in grave chambers, with no statistically significant difference between them (Fig. 7.46; Table 7.8). However, the small sample size for Neresheim males buried in grave chambers (n = 3) proves to be a problem, hence any observations can only be indicative. At Pleidelsheim, no significant difference between the three grave types could be determined either (Table 7.8), and males buried in coffins also exhibit the highest prevalence of minor and major EC in the UL, closely followed by males in chamber burials with regard to minor EC (Fig. 7.45). However, in this cemetery, males buried in 'simple' graves demonstrate the overall lowest frequency of EC, despite a higher number of major EC detectable compared to individuals in grave chambers (Fig. 7.45).

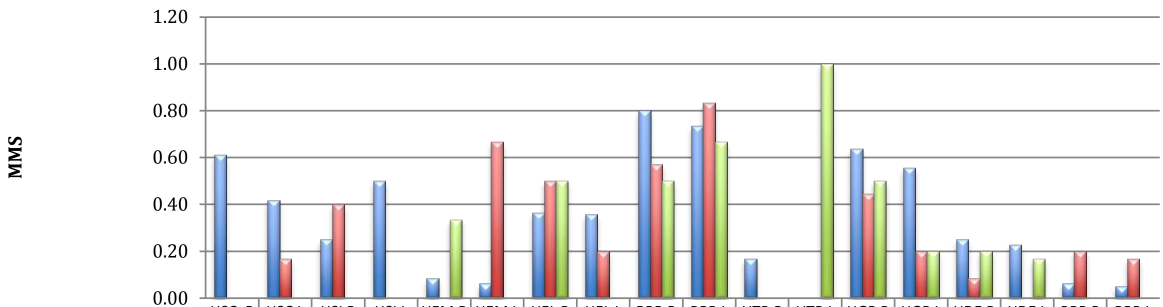
Table 7.8: Total UL MSM mean muscle scores and p-values for significant differences between the three burial types for males at the two sites of Pleidelsheim and Neresheim

Site		Males - UL		
		burial type A[1)]	burial type B[2)]	burial type C[3)]
Pleidelsheim n=78	**MMS**	0.37	0.21	0.28
	p - value		NS	
Neresheim n=41	**MMS**	0.46	0.35	0.18
	p - value		NS	

[1)] coffin burial; [2)] 'simple' burial; [3)] chamber burial; one-way ANOVA with Bonferroni correction: NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

In order to clarify these patterns for EC in the UL of males, a look at the MMS at individual entheses of males buried in different grave types proves beneficial (Fig. 7.47; Fig. 7.48). It is apparent that males found buried in coffins in both populations display EC at the great majority of entheses. In males buried in grave chambers at Pleidelsheim, half of all observed UL entheses are affected by osseous changes (Fig. 7.47), explaining the relatively high prevalence of minor EC in this group. Moreover, males in grave type C do not only demonstrate changes to those muscle attachments that belong to the range of the highest scoring muscles (cf. Table 7.1), but also to the entheses of the flexors and extensors of the right hand and fingers, as well as, notably, to the insertion of the left *M. triceps brachii*, as the only of the three burial groups and, as outlined before (cf. Fig. 7.37), only during old adulthood. Effectively, the pattern that can be deduced in terms of EC for males in grave chambers at Pleidelsheim comprises the frequent adduction, abduction and supination of the arms, extension and flexion of the right hand and fingers, as well as increased stress to the left forearm extensor with older age. As changes to the entheses of the extensors of the right hand and fingers (HEL R), right *M. pectoralis* and *M. deltoideus* occur already during young adulthood among Pleidelsheim males (Fig. 7.37; Table 7.7), patterns of EC involving these muscles in males buried in grave chambers can be considered activity- rather than age-related.

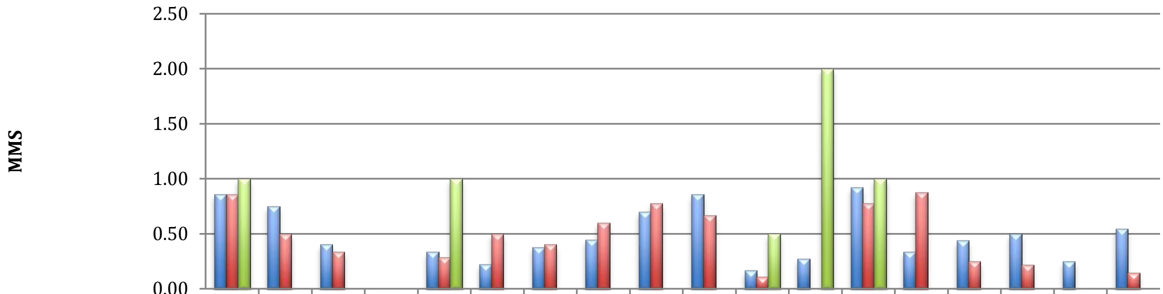
At Neresheim, males buried in grave chambers show changes only to five out of 18 UL entheses, distinctly mainly on the right side (Fig. 7.48). Only *M. subscapularis* and *M. pectoralis* belong to those muscles that occur among the highest-ranking ones for males at Neresheim (cf. Table 7.1); apart from these two muscles, none of the observed entheses appearing in males from chamber burials occur already at young age (cf. Fig. 7.41), including the left lateral extensors (HEL L) which stand out as distinguishing muscles in the rank ordering for males at Neresheim (cf. Table 7.7).



	HSC R	HSC L	HSI R	HSI L	HEM R	HEM L	HEL R	HEL L	RBB R	RBB L	UTB R	UTB L	HGP R	HGP L	HDE R	HDE L	RRP R	RRP L
MMS A (coffin)	0.61	0.42	0.25	0.50	0.08	0.06	0.36	0.36	0.80	0.73	0.17	0.00	0.64	0.56	0.25	0.23	0.06	0.05
MMS B ('simple' grave)	0.00	0.17	0.40	0.00	0.00	0.67	0.50	0.20	0.57	0.83	0.00	0.00	0.44	0.20	0.08	0.00	0.20	0.17
MMS C (chamber grave)	0.00	0.00	0.00	0.00	0.33	0.00	0.50	0.00	0.50	0.67	0.00	1.00	0.50	0.20	0.20	0.17	0.00	0.00

enthesis

Fig. 7.47: Distribution of UL MMS by enthesis and burial type - Pleidelsheim: Males



	HSC R	HSC L	HSI R	HSI L	HEM R	HEM L	HEL R	HEL L	RBB R	RBB L	UTB R	UTB L	HGP R	HGP L	HDE R	HDE L	RRP R	RRP L
MMS A (coffin)	0.86	0.75	0.40	0.00	0.33	0.22	0.38	0.44	0.70	0.86	0.17	0.27	0.92	0.33	0.44	0.50	0.25	0.55
MMS B ('simple' grave)	0.86	0.50	0.33	0.00	0.29	0.50	0.40	0.60	0.78	0.67	0.11	0.00	0.78	0.88	0.25	0.21	0.00	0.14
MMS C (chamber grave)	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.50	2.00	1.00	0.00	0.00	0.00	0.00	0.00

enthesis

Fig. 7.48: Distribution of UL MMS by enthesis and burial type - Neresheim: Males

Fig. 7.49 and Fig. 7.50 display the prevalence of minor and major EC in the UL of females from both populations according to the three grave types. Both profiles are consistent in the pattern of females buried in most simple manner exhibiting the highest prevalence of EC, albeit at Pleidelsheim, major EC are less frequent here than in females from coffin burials (Fig. 7.49). Following that, the prevalence of EC in the UL in females buried in grave chambers surpasses that of females in coffins. At Pleidelsheim, this difference is only marginal, and interestingly, females in grave chambers demonstrate no indication of major EC to their UL (Fig. 7.49), while at Neresheim, even the prevalence of major EC traced in females from grave chambers exceeds that of females buried in coffins (Fig. 7.50). None of the described differences could be determined as statistically significant (Table 7.9).

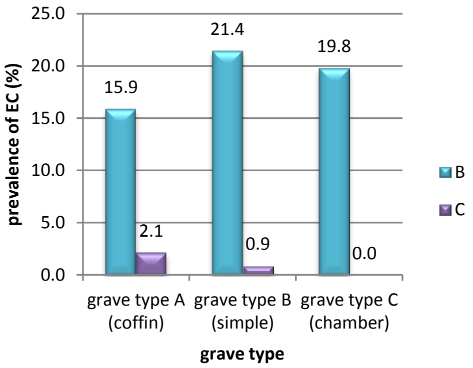


Fig. 7.49: Distribution of muscle scores in various grave types: Pleidelsheim - Females, UL

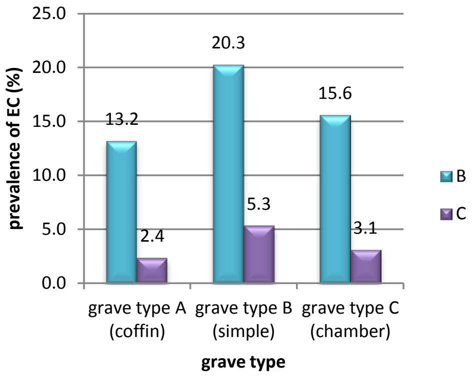


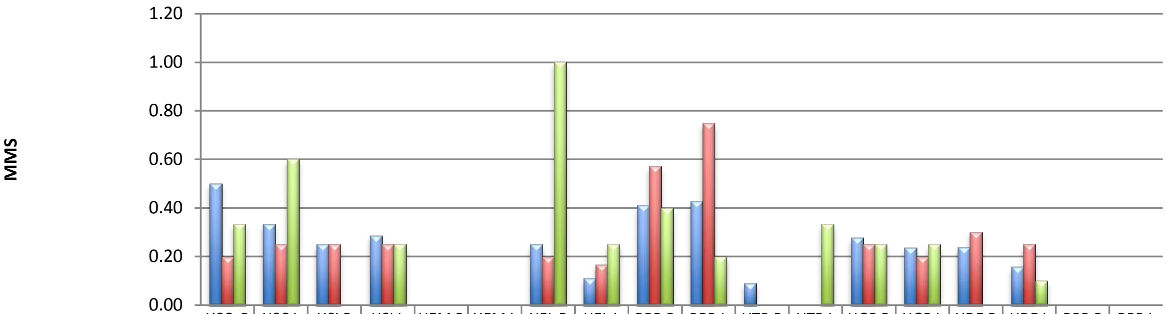
Fig. 7.50: Distribution of muscle scores in various grave types: Neresheim - Females, UL

Table 7.9: Total UL MSM mean muscle scores and p-values for significant differences between the three burial types for females at the two sites of Pleidelsheim and Neresheim

Site		Females - UL		
		burial type A[1)]	burial type B[2)]	burial type C[3)]
Pleidelsheim n=84	**MMS**	0.22	0.34	0.19
	p - value		NS	
Neresheim n=79	**MMS**	0.17	0.34	0.21
	p - value		NS	

[1)] coffin burial; [2)] 'simple' burial; [3)] chamber burial; one-way ANOVA with Bonferroni correction: NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

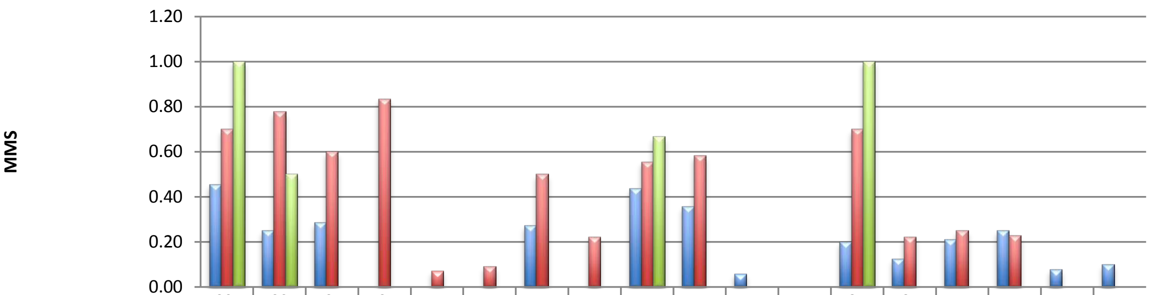
The profiles of MSM patterns for females in varying grave types with regard to individual entheses highlight the great consistency of EC in the UL of females regardless of burial type at Pleidelsheim (Fig. 7.51), and, as previously observed, no EC can be observed in YA females from this population (Fig. 7.39; Table 7.7). At Neresheim, EC in females from chamber burials, albeit relatively strong, are more concentrated on only four entheses out of the 18 analysed (Fig. 7.52). The sample size for Neresheim females buried in grave chambers is too small (n = 4) for an exhaustive consideration, but the patterns observed are nonetheless informative regarding the lack of differentiation by burial type.



	HSC R	HSC L	HSI R	HSI L	HEM R	HEM L	HEL R	HEL L	RBB R	RBB L	UTB R	UTB L	HGP R	HGP L	HDE R	HDE L	RRP R	RRP L
MMS A (coffin)	0.50	0.33	0.25	0.29	0.00	0.00	0.25	0.11	0.41	0.43	0.09	0.00	0.28	0.24	0.24	0.16	0.00	0.00
MMS B ('simple' grave)	0.20	0.25	0.25	0.25	0.00	0.00	0.20	0.17	0.57	0.75	0.00	0.00	0.25	0.20	0.30	0.25	0.00	0.00
MMS C (chamber grave)	0.33	0.60	0.00	0.25	0.00	0.00	1.00	0.25	0.40	0.20	0.00	0.33	0.25	0.25	0.00	0.10	0.00	0.00

enthesis

Fig. 7.51: Distribution of UL MMS by enthesis and burial type - Pleidelsheim: Females



	HSC R	HSC L	HSI R	HSI L	HEM R	HEM L	HEL R	HEL L	RBB R	RBB L	UTB R	UTB L	HGP R	HGP L	HDE R	HDE L	RRP R	RRP L
MMS A (coffin)	0.45	0.25	0.29	0.00	0.00	0.00	0.27	0.00	0.44	0.36	0.06	0.00	0.20	0.13	0.21	0.25	0.08	0.10
MMS B ('simple' grave)	0.70	0.78	0.60	0.83	0.07	0.09	0.50	0.22	0.56	0.58	0.00	0.00	0.70	0.22	0.25	0.23	0.00	0.00
MMS C (chamber grave)	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00

enthesis

Fig. 7.52: Distribution of UL MMS by enthesis and burial type - Neresheim: Females

The muscles exhibiting EC in females from grave chambers - *M. subscapularis*, right *M. biceps brachii* and *M. pectoralis* - do occur among the highest-ranking ones for Neresheim females (cf. Table 7.1), and notably, all of them, except the left M. subscapularis, also occur in YA females at Neresheim (cf. Fig. 7.43), suggesting that especially during young adulthood, no difference can be detected with regard to patterns of activity reflected in muscular strain between females buried in any of the three burial types. In contrast to that, the profile reveals that females showing changes to those muscles exhibiting higher scores exclusively at old age (i.e. right *M.*

biceps brachii and, bilaterally, *M. pronator teres*; cf. Table 7.7) are only found in coffin burials (Fig. 7.52).

b) Lower limb

The analysis of the patterns of prevalences of EC in the LL of males buried in varying grave types at Pleidelsheim and Neresheim also resulted in no statistically significant difference between the groups (Table 7.10).

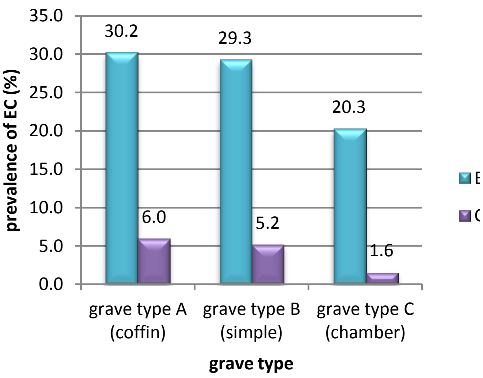


Fig. 7.53: Distribution of muscle scores in various grave types: Pleidelsheim - Males, LL

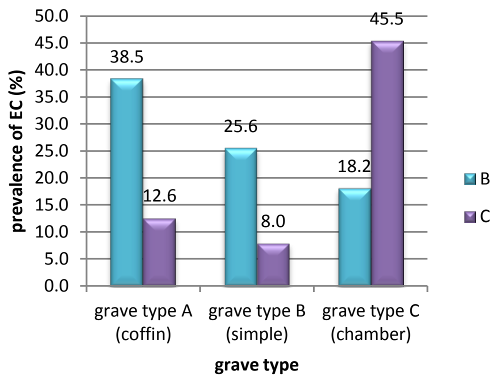


Fig. 7.54: Distribution of muscle scores in various grave types: Neresheim - Males, LL

Table 7.10: Total LL MSM mean muscle scores and p-values for significant differences between the three burial types for males at the two sites of Pleidelsheim and Neresheim

Site		Males - LL		
		burial type A[1)]	burial type B[2)]	burial type C[3)]
Pleidelsheim n=78	**MMS**	0.40	0.36	0.32
	p - value		NS	
Neresheim n=41	**MMS**	0.54	0.29	0.86
	p - value		NS	

[1)] coffin burial; [2)] 'simple' burial; [3)] chamber burial; one-way ANOVA with Bonferroni correction: NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

At Pleidelsheim (Fig. 7.53), males buried in coffins show the highest amount of EC in the LL, followed by males interred in the most simple style and, with the lowest prevalence of EC, by males found buried in grave chambers. An investigation of EC of individual entheses did not yield significant results with regard to a differential pattern of EC among the three burial types, apart from the observation that males buried in grave chambers only show EC in their LL for the muscles *M. iliopsoas, M. gluteus maximus, M. soleus* (all among the highest scoring muscles for Pleidelsheim males, cf. Table 7.1), as well as *Mm. quadriceps femoris*, and the left *Mm. vastus medialis, adductor magnus and longus*.

In the LL of males at Neresheim (Fig. 7.54), the number of major EC observed in the LL of males interred in chamber burials is very distinctive, while males buried in 'simple' graves show the lowest number of EC overall. However, a more detailed analysis of the changes of individual entheses of males in any of the three burial types does not suggest a particular pattern in LL entheseal alterations that would distinguish the groups from each other (Fig. 7.55). Due to the small sample size of male individuals in chamber burials, it can only be established that the EC observable in the LL of these individuals differs completely from that detected in males buried in the same mode at Pleidelsheim, apart from *M. gluteus maximus* and the hip adductor and leg extension muscles (FLA). The left *M. gluteus minimus* and *medius*, as well as the left *Mm. triceps surae* appear as particularly highly expressed in males found buried in grave chambers (Fig. 7.55).

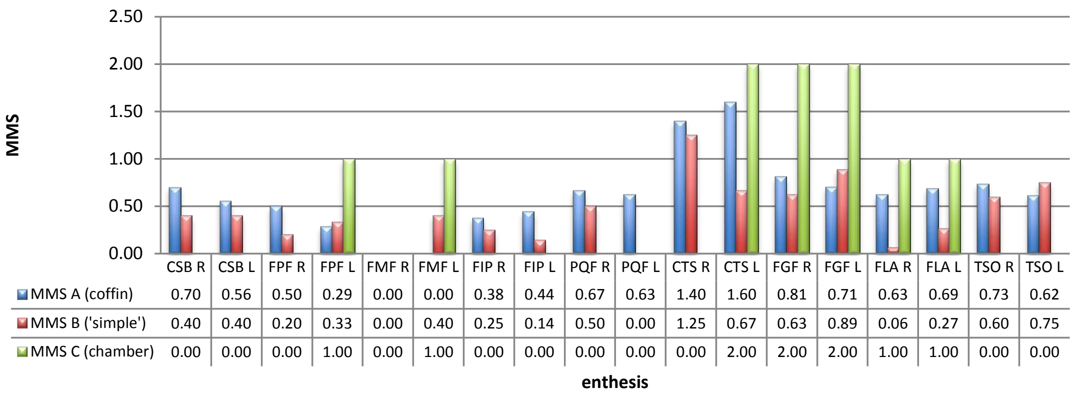


Fig. 7.55: Distribution of LL MMS by enthesis and burial type - Neresheim: Males

With regard to the female groups from Pleidelsheim and Neresheim, the analysis of EC in the LL did not result in any either statistically significant difference or very dissimilar patterns considering the different burial modes (Table 7.11; Fig. 7.56; Fig. 7.57).

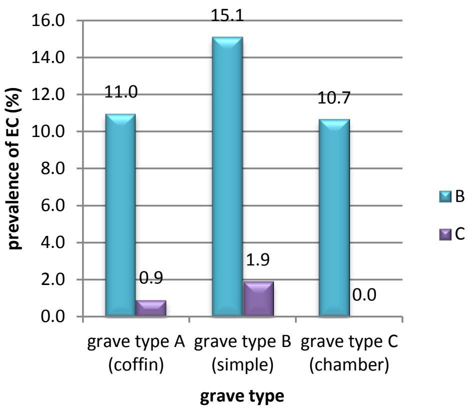


Fig. 7.56: Distribution of muscle scores in various grave types: Pleidelsheim - Females, LL

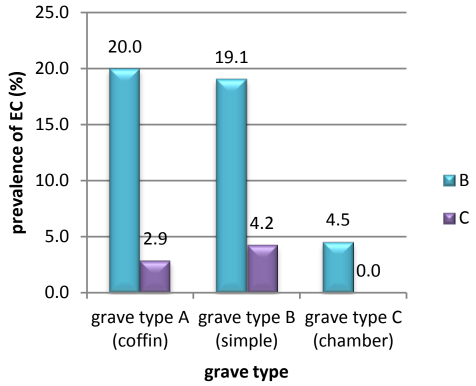


Fig. 7.57: Distribution of muscle scores in various grave types: Neresheim - Females, LL

Table 7.11: Total LL MSM mean muscle scores and p-values for significant differences between the three burial types for females at the two sites of Pleidelsheim and Neresheim

Site		Females - LL		
		burial type A[1)]	burial type B[2)]	burial type C[3)]
Pleidelsheim n=84	**MMS**	0.11	0.23	0.08
	p - value	NS		
Neresheim n=79	**MMS**	0.30	0.29	0.03
	p - value	NS		

[1)] coffin burial; [2)] 'simple' burial; [3)] chamber burial; one-way ANOVA with Bonferroni correction: NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

In both populations, females in chamber burials do not exhibit major EC, albeit the sample size from Neresheim is only very small. At Pleidelsheim (Fig. 7.56), females in 'simple' graves show the highest prevalence of EC, while at Neresheim (Fig. 7.57), the frequencies are very similar for females interred in coffins and those buried in 'simple' graves, although the latter display a higher prevalence of major EC. The examination of MSM patterns for individual entheses among the three burial types did not produce any notable differences.

Overall, there are indications, especially in the UL, for individuals in chamber burials to possess frequencies of entheseal alterations that vary from those individuals in less elaborate grave types, particularly regarding activity-related patterns in the UL of individuals during young adulthood.

7.2.1.2 MSM and burial groups at Pleidelsheim and Neresheim

Fig. 7.58 and Fig. 7.59 demonstrate the collation of find frequencies of AT as discussed in Chapter 5 within broad age categories for males and females at Pleidelsheim and Neresheim, in comparison with overall prevalences of EC in the UL in the population groups.

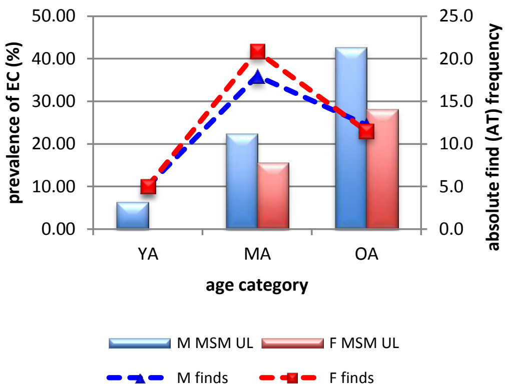


Fig. 7.58: Pleidelsheim - Prevalence of UL EC and find frequencies for males and females by age category

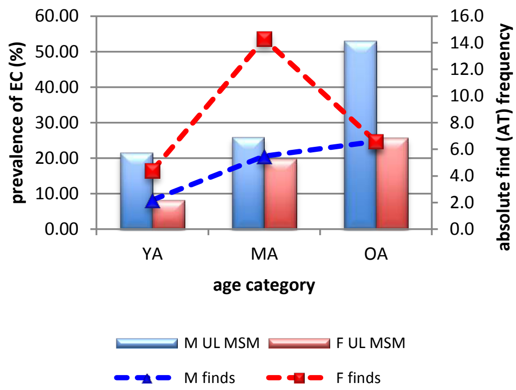


Fig. 7.59: Neresheim - Prevalence of UL EC and find frequencies for males and females by age category

In both cases, this graph reiterates the rates for an increase of EC with advancing age (cf. Chapter 6) as well as the artefact-type abundance found in burials of males and females within each particular age category (cf. Chapter 5), yet the combined display of both occurrences suggests no direct reflection of artefact presence and indicators of increased physical activity. A frequent or continuous strain on the body by physical activity does not seem to coincide with the level of esteem that might be expressed by the presence and / or abundance of AT in the burials, albeit in Neresheim OA males, an increase in both MSM and number of artefacts can be observed (Fig. 7.59).

Therefore, it is of interest to examine age-related differences observable within burial groups in more detail, as well as differences between individuals of these burial groups, in order to determine whether the presence of EC can provide biological definition of these groups.

a) Upper limb

Males

Tables 18 and 19 (male burial groups) as well as Tables 20 and 21 (female burials groups) in App. 7 demonstrate the prevalence of EC in each scoring and age category for individuals buried with and without GG at Pleidelsheim and Neresheim.

Within the burial groups 'M GG' (males buried with GG) and 'M N GG' (males buried without GG), significant differences regarding the prevalence of EC in the UL could only be found in

a) the Pleidelsheim group 'M N GG', albeit the lack of EC observed in the MA male sample can be ascribed to a very small sample size (n = 2) and is therefore not of importance;

b) the Neresheim group 'M GG', where the significantly higher MMS in OA males buried with GG can be attributed to the age-related progress in the occurrence of EC as well as the presence of major EC (Fig. 7.62). Unfortunately, there were no data regarding EC observable in the YA and MA groups for M N GG at Neresheim (App. 7, Table 18).

Table 7.12: Total UL MSM mean muscle scores and p-values for significant differences between the three age categories (using χ^2) for males buried with and without grave goods in the two sites of Pleidelsheim and Neresheim

Site			**M GG**			**M N GG**		
			YAM	**MAM**	**OAM**	**YAM**	**MAM**	**OAM**
Pleidelsheim	**MMS**		0.00	0.25	0.50	0.70	0.00	0.98
GG: n=51	**p - value**	YA		NS			.01**	
no GG: n=6		MA	NS		NS	.01**		.01**
Neresheim GG:	**MMS**		0.15	0.19	0.58	ND	ND	0.62
n=13	**p - value**	YA		NS			ND	
no GG: n=4		MA	NS		.000**	ND		ND

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

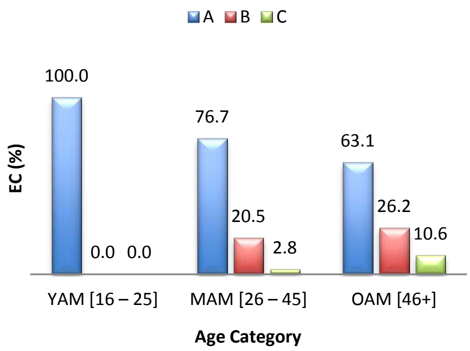


Fig. 7.60: Pleidelsheim: Prevalence of EC - M GG, UL

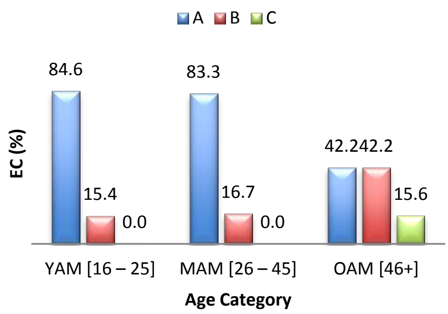


Fig. 7.62: Neresheim: Prevalence of EC - M GG - UL

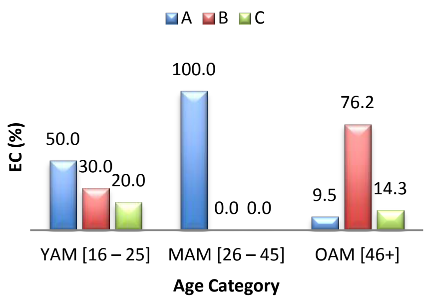


Fig. 7.61: Pleidelsheim: Prevalence of EC - M N GG, UL

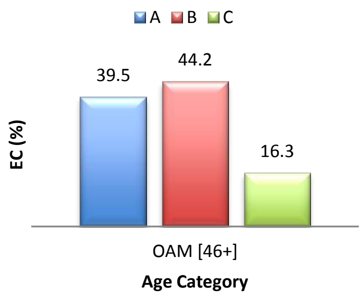


Fig. 7.63: Neresheim: Prevalence of EC - M N GG - UL

Notably, YA males buried with GG at Pleidelsheim (Fig. 7.60) show no evidence of EC of their UL, while with advancing age development of EC takes its normal course (App. 7, Table 18). In YA males buried without GG at Pleidelsheim, however, EC during young adulthood are comparatively high, including minor and major changes, though the difference between burial groups is not statistically significant (Table 7.13). Despite the absence of significant differences between the male burial groups, the data for the UL (MMS as well as prevalences of EC, cf. App. 7, Table 18) for males in both populations are suggestive of generally higher levels of EC in the group 'M N GG'.

Table 7.13: Total UL MSM mean muscle scores and p-values for significant differences between the two groups (using independent samples t-test) for males buried with and without grave goods in the two sites of Pleidelsheim and Neresheim

Site		M GG * M N GG: UL			
		all M	YAM	MAM	OAM
Pleidelsheim	**MMS [a]**	0.31 * 0.67	0.00 * 0.70	0.25 * 0.00	0.50 * 0.98
n=57	**p - value**	NS	ND	ND	NS
Neresheim	**MMS [a]**	0.40 * 0.62	0.15 * ND	0.19 * ND	0.58 * 0.62
n=17	**p - value**	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = M GG, second value = M N GG

A comparison of male burial groups of both populations did not result in statistically significant differences for any group (Table 7.14). However, males at middle adulthood buried with GG at Neresheim exhibit a lower mean of EC than males in the same burial group at Pleidelsheim (Table 7.14; Fig. 7.60; Fig. 7.62). The same can be observed in the OA category for males buried without GG (Table 7.14), and indicates that OA males at Pleidelsheim buried without GG show a higher prevalence of EC to the UL than those at Neresheim, something that could potentially be the case for all age categories, as the comparison of MMS for all M N GG suggests (Table 7.14).

Table 7.14: Inter-population comparison. Total UL MSM mean muscle scores and p-values for significant differences between males buried with and without grave goods in the two sites of Pleidelsheim and Neresheim (using independent samples t-test)

Burial group		PH M * NE M: UL			
		all M	YAM	MAM	OAM
GG	**MMS [a]**	0.31 * 0.40	0.00 * 0.15	0.25 * 0.19	0.50 * 0.58
	p - value	NS	ND	NS	NS
no GG	**MMS [a]**	0.67 * 0.62	0.70 * ND	0.00 * ND	0.98 * 0.62
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH M, second value = NE M

Females

Considering the prevalence of EC within the burial groups ‘F GG’ (females buried with GG) and ‘F N GG’ (females buried without GG; App. 7, Table 20), no significant differences could be found with regard to differences between the age categories in each burial group (Table 7.15). At Pleidelsheim, females in the YA category either exhibited absence of EC in the UL (F GG) or provided no data available for observation (F N GG). Only one female buried without GG at Pleidelsheim was available in the MA category, rendering a meaningful analysis impossible. Overall, a similar increase of EC with advancing age is indicative for both burial groups at Pleidelsheim and Neresheim.

Table 7.15: Total UL MSM mean muscle scores and p-values for significant differences between the three age categories (using χ^2) for females buried with and without grave goods in the two sites of Pleidelsheim and Neresheim

Site			F GG			F N GG		
			YAF	**MAF**	**OAF**	**YAF**	**MAF**	**OAF**
Pleidelsheim	**MMS**		0.00	0.19	0.22	ND	0.00	0.53
GG: n=52	**p - value**	YA		NS			ND	
no GG: n=8		MA	NS		NS	ND		ND
Neresheim GG:	**MMS**		0.07	0.21	0.76	ND	0.24	0.40
n=24	**p - value**	YA		NS			ND	
no GG: n=18		MA	NS		NS	ND		NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

Furthermore, no significant difference was traceable in the comparison of females buried with and those buried without GG at both Pleidelsheim and Neresheim (Table 7.16). It is noteworthy that while at Pleidelsheim, a relatively high prevalence of EC is present in F N GG compared to those F GG, MMS for both burial groups are equivalent at Neresheim, albeit a preponderance of EC being indicated in F GG during old adulthood (Table 7.16).

Table 7.16: Total UL MSM mean muscle scores and p-values for significant differences between the two groups (using independent samples t-test) for females buried with and without weaponry in the two sites of Pleidelsheim and Neresheim

Site		F GG * F N GG: UL			
		all F	**YAF**	**MAF**	**OAF**
Pleidelsheim	**MMS** [a]	0.18 * 0.45	0.00 * ND	0.19 * 0.00	0.22 * 0.53
n=60	**p - value**	NS	ND	ND	NS
Neresheim	**MMS** [a]	0.29 * 0.29	0.07 * ND	0.21 * 0.24	0.76 * 0.40
n=18	**p - value**	NS	ND	NS	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = F GG, second value = F N GG

The inter-population comparison of UL EC in female burial groups (Table 7.17) shows no statistically significant difference for any group. However, it is revealed that while F GG at Neresheim show a higher prevalence of EC than F GG at Pleidelsheim throughout life, at old age even more marked than earlier in life (Table 7.17; cf. App. 7, Table 20), the reverse is the case in the burial group 'F N GG', similarly to patterns observed in the male burial groups (cf. Table 7.14): Pleidelsheim females show a slightly higher MMS in the group 'F N GG' overall and during old adulthood than females at Neresheim (Table 7.17).

Table 7.17: Inter-population comparison. Total UL MSM mean muscle scores and p-values for significant differences between females buried with and without grave goods in the two sites of Pleidelsheim and Neresheim (using independent samples t-test)

Burial group		PH F * NE F: UL			
		all F	YAF	MAF	OAF
GG	MMS [a]	0.18 * 0.29	0.00 * 0.07	0.19 * 0.21	0.22 * 0.76
	p - value	NS	NS	NS	NS
no GG	MMS [a]	0.45 * 0.29	ND	0.00 * 0.24	0.53 * 0.40
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH F, second value = NE F

Intra-population comparisons

At Pleidelsheim, the pattern for the occurrence of EC does not deviate from what has been observed with regard to the total population (cf. Chapter 7.1), as males show evidence of more EC in the UL than females in both burial groups, buried with or without GG (Table 7.18). This is statistically significant in the OA category (Table 7.18). Thus, males at Pleidelsheim would always display evidence of higher physical stress reflected in the muscular entheses of the UL, irrespective of burial group and age category.

Table 7.18: Intra-population comparison. Total UL MSM mean muscle scores and p-values for significant differences between males and females buried with and without grave goods in Pleidelsheim (using independent samples t-test)

Burial group		PH M * PH F: UL			
		all	YA	MA	OA
GG	MMS [a]	0.31 * 0.18	0.00 * 0.00	0.25 * 0.19	0.50 * 0.22
	p - value	NS	ND	ND	.016*
no GG	MMS [a]	0.67 * 0.45	0.70 * ND	0.00 * 0.00	0.98 * 0.53
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH M, second value = PH F

At Neresheim, the comparison of overall MMS suggests the same pattern (Table 7.19). Yet a closer look at the occurrence of EC divided by age for those individuals buried with GG as well as those buried without reveals that a higher prevalence of EC in the UL in males is only indicated throughout life for those without GG (Table 7.19). Among the burials including GG, females seem to show more EC in their UL than males during middle adulthood (Table 7.19) due to a combination of a slightly higher prevalence of minor EC (F GG, MA: 17.8 %) and the presence of major EC (F GG, MA: 3.7%, as opposed to 0% in M GG, MA; cf. App. 7, Tables 18 and 20).

Table 7.19: Intra-population comparison. Total UL MSM mean muscle scores and p-values for significant differences between males and females buried with and without grave goods in Neresheim (using independent samples t-test)

Burial group		NE M * NE F: UL			
		all	YA	MA	OA
GG	MMS [a]	0.40 * 0.29	0.15 * 0.07	0.19 * 0.21	0.58 * 0.76
	p - value	NS	ND	NS	NS
no GG	MMS [a]	0.62 * 0.29	ND	ND * 0.24	0.62 * 0.40
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = NE M, second value = NE F *b) Lower limb*

Males

Patterns of the prevalence of EC in the LL within the burial groups 'M GG' and 'M N GG' (cf. App. 7, Table 19) reflect the observations made for the UL (cf. Table 7.12), with overall increased scores of EC due to influences to the LL such as body weight bearing and locomotion. The difference detected within the Pleidelsheim group 'M N GG' is statistically significant (Table 7.20), as the EC observed in OA males in this burial group are markedly more frequent than in younger males buried without GG, especially with regard to major EC (Fig. 7.65), despite the lack of sufficient observable male individuals in the MA category. In the Neresheim group 'M GG', OA males show significantly higher MMS than younger males (Table 7.20), again a consequence of age-related increase in EC as well as the additional occurrence of major EC during old adulthood (Fig. 7.65).

Table 7.20: Total LL MSM mean muscle scores and p-values for significant differences between the three age categories (using χ^2) for males buried with and without grave goods in the two sites of Pleidelsheim and Neresheim

Site			**M GG**			**M N GG**		
			YAM	**MAM**	**OAM**	**YAM**	**MAM**	**OAM**
Pleidelsheim	**MMS**		0.11	0.39	0.63	0.79	0.00	1.70
GG: n=51	**p - value**	YA		NS			NS	
no GG: n=6		MA	NS		NS	NS		.000**
Neresheim GG: n=13	**MMS**		0.09	0.23	0.53	ND	ND	0.66
	p - value	YA		NS			ND	
no GG: n=4		MA	NS		.000**	ND		ND

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

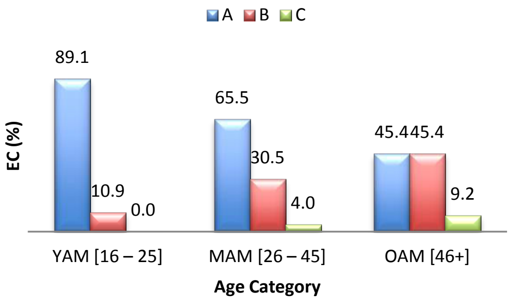


Fig. 7.64: Pleidelsheim: Prevalence of EC - M GG, LL

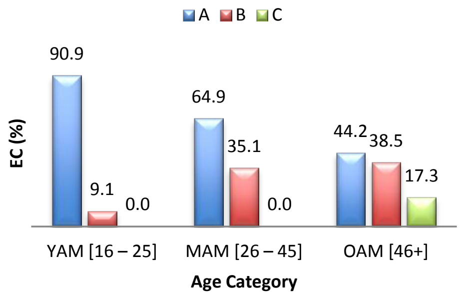


Fig. 7.66: Neresheim: Prevalence of EC - M GG - LL

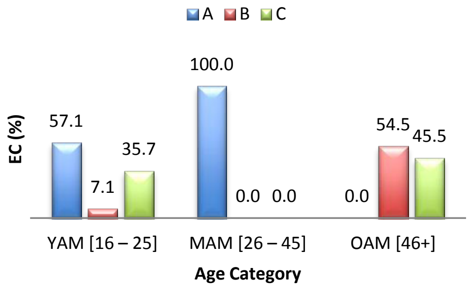


Fig. 7.65: Pleidelsheim: Prevalence of EC - M N GG, LL

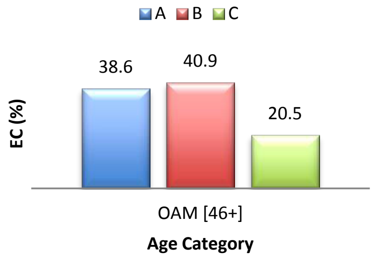


Fig. 7.67: Neresheim: Prevalence of EC - M N GG - LL

No statistically significant difference could be discerned between M GG and M N GG at Neresheim (Table 7.21), with a comparison for YA and MA males impossible due to the lack of data, and merely slightly higher values observable for males buried without GG (cf. App. 7, Table 19). At Pleidelsheim, higher MMS for M N GG can be observed in all age categories but one, middle adulthood (Table 7.21; Fig. 7.64, Fig. 7.65), which displays significantly more EC in males buried with GG. Although not valid in statistical terms, due to the very small sample size of MA males buried without GG, it indicates that males who passed away during middle adulthood and were buried with GG exhibit greater entheseal alterations than those buried without GG, supporting the findings made in the analysis of skeletal data overall (cf. Chapter 6).

Table 7.21: Total LL MSM mean muscle scores and p-values for significant differences between the two groups (using independent samples t-test) for males buried with and without weaponry in the two sites of Pleidelsheim and Neresheim

Site		**M GG * M N GG: LL**			
		all M	**YAM**	**MAM**	**OAM**
Pleidelsheim n=57	**MMS [a]**	0.44 * 0.84	0.11 * 0.79	0.39 * 0.00	0.63 * 1.70
	p - value	NS	ND	[.000**]	NS
Neresheim n=17	**MMS [a]**	0.40 * 0.66	0.09 * ND	0.23 * ND	0.53 * 0.66
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = M GG, second value = M N GG

The comparison of EC in the LL of M GG and of M N GG buried at Pleidelsheim and Neresheim reveals an overall higher prevalence of osseous changes to muscular attachments in males from Pleidelsheim, albeit in no case significantly so (Table 7.22). While for M N GG, this could only be demonstrated for the OA category (Fig. 7.65; Fig. 7.67), due to the lack of data, higher MMS can be observed for Pleidelsheim males buried with GG throughout life, compared to Neresheim males in the same burial category (Table 7.22).

Table 7.22: Inter-population comparison. Total LL MSM mean muscle scores and p-values for significant differences between males buried with and without grave goods in the two sites of Pleidelsheim and Neresheim (using independent samples t-test)

Burial group		**PH M * NE M: LL**			
		all M	**YAM**	**MAM**	**OAM**
GG	**MMS [a]**	0.44 * 0.40	0.11 * 0.09	0.39 * 0.23	0.63 * 0.53
	p - value	NS	ND	NS	NS
no GG	**MMS [a]**	0.84 * 0.66	0.79 * ND	0.00 * ND	1.70 * 0.66
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH M, second value = NE M

Overall, this suggests that males at Neresheim may exhibit more EC overall (cf. Chapter 7.1.3.2, Fig. 7.24), but divided into burial groups, it emerges that Pleidelsheim males buried without GG have a tendency for more EC in both UL and LL than males of the same group at Neresheim.

Females

The burial groups ‘F N GG’ at Pleidelsheim and Neresheim did not provide sufficient observable data for the analysis and comparison of EC in various age categories (cf. App. 7, Table 21). Merely an increase of LL EC can be noted in this burial group for Neresheim (Table 7.23). In both cemetery populations, a significant difference regarding the prevalence of EC in the LL was observable, however, for the burial group ‘F GG’. At Pleidelsheim, OA females in this burial group show significantly fewer minor EC than MA females (Table 7.23), and even slightly fewer than those in the YA category (Fig. 7.68). This departs from the observations made previously considering the entire female population (cf. Chapter 7.1.3.2; Fig. 7.28), for which a constant, albeit not particularly steep, increase of EC could be noted.

The significant difference detected for OA females as opposed to MA females buried with GG at Neresheim complies with previous observations regarding the age-related development of EC in the LL (cf. Chapter 7.1.3.2; Fig. 7.34), as especially major EC traced in the LL see a precipitous increase from 2.3% in MA females to 10% in OA females (Fig. 7.69; cf. App. 7, Table 21).

Table 7.23: Total LL MSM mean muscle scores and p-values for significant differences between the three age categories (using χ^2) for females buried with and without grave goods in the two sites of Pleidelsheim and Neresheim

Site			F GG			F N GG		
			YAF	MAF	OAF	YAF	MAF	OAF
Pleidelsheim	**MMS**		0.05	0.18	0.12	ND	ND	0.34
GG: n=52	**p - value**	YA		NS			ND	
no GG: n=8		MA	NS		.029*	ND		ND
Neresheim GG:	**MMS**		0.00	0.27	0.43	ND	0.18	0.59
n=24	**p - value**	YA		NS			ND	
no GG: n=18		MA	NS		.025*	ND		NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

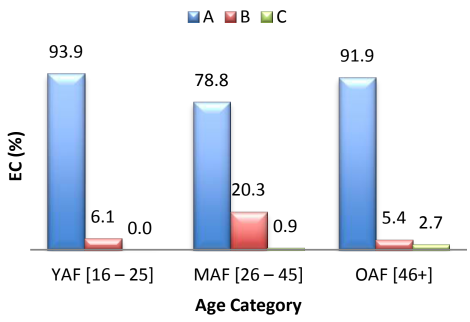


Fig. 7.68: Pleidelsheim: Prevalence of EC - F GG, LL

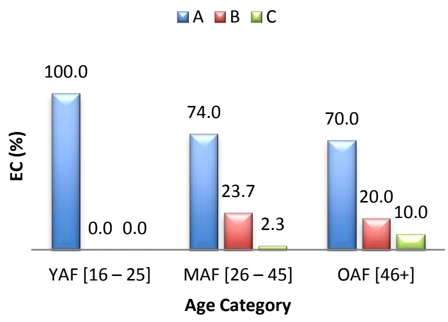


Fig. 7.69: Neresheim: Prevalence of EC - F GG, LL

Due to the absence of observable data for YA and MA females buried without GG at Pleidelsheim and Neresheim, a comparison with regard to potential differences in the intensity and / or frequency of muscle use in the LL could only be successfully made for the total number of females within the burial groups, as well as for OA females, and did not yield any significant results (Table 7.24). In both populations, females buried without GG seem to exhibit a greater number of EC, although there is a trend for F GG to show slightly more EC than F N GG during middle adulthood, due to a higher amount of minor EC in F GG (cf. App. 7, Table 21).

Table 7.24: Total LL MSM mean muscle scores and p-values for significant differences between the two groups (using independent samples t-test) for females buried with and without weaponry in the two sites of Pleidelsheim and Neresheim

Site		F GG * F N GG: LL			
		all F	YAF	MAF	OAF
Pleidelsheim	**MMS [a]**	0.15 * 0.34	0.05 * ND	0.18 * ND	0.12 * 0.34
n=60	**p - value**	NS	ND	ND	NS
Neresheim	**MMS [a]**	0.27 * 0.34	0.00 * ND	0.27 * 0.18	0.43 * 0.59
n=18	**p - value**	NS	ND	NS	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = F GG, second value = F N GG

An inter-population comparison of LL EC in female burial groups reveals that with the exception of YA females, females buried with GG at Neresheim show higher MMS than those at Pleidelsheim (Table 7.25; cf. App. 7, Table 21). Females buried without GG show an equal amount of EC in the LL (Table 7.25), although with advancing age, also here a higher prevalence of EC can be observed for females at Neresheim (OAF, Table 7.25).

Table 7.25: Inter-population comparison. Total LL MSM mean muscle scores and p-values for significant differences between females buried with and without grave goods in the two sites of Pleidelsheim and Neresheim (using independent samples t-test)

Burial group		PH F * NE F: LL			
		all F	**YAF**	**MAF**	**OAF**
GG	**MMS [a]**	0.15 * 0.27	0.05 * 0.00	0.18 * 0.27	0.12 * 0.43
	p - value	NS	NS	NS	NS
no GG	**MMS [a]**	0.34 * 0.34	ND	ND * 0.18	0.34 * 0.59
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH F, second value = NE F

Intra-population comparison

The preponderance of LL EC in Pleidelsheim males compared to females is visible for both burial groups, individuals buried with and without GG, similar to patterns observed in the UL (Table 7.18). Considering males and females interred with GG, this difference is statistically significant overall as well as for individuals during middle and old adulthood (Table 7.26), while for the burial group ‘N GG’, this relationship is indicated by comparison of the total number of individuals as well as those within the OA category (Table 7.26).

Table 7.26: Intra-population comparison. Total LL MSM mean muscle scores and p-values for significant differences between males and females buried with and without grave goods in Pleidelsheim (using independent samples t-test)

Burial group		PH M * PH F: LL			
		all	**YA**	**MA**	**OA**
GG	**MMS [a]**	0.44 * 0.15	0.11 * 0.05	0.39 * 0.18	0.63 * 0.12
	p - value	.000**	NS	.038*	.002**
no GG	**MMS [a]**	0.84 * 0.34	0.79 * ND	0.00 * ND	1.70 * 0.34
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH M, second value = PH F

At Neresheim, entheses in the LL allow a similar, albeit less significantly marked observation (Table 7.27). Only during middle adulthood are the MMS for males and females buried with GG almost identical (Table 7.27; cf. App. 7, Tables 19 and 21).

Table 7.27: Intra-population comparison. Total LL MSM mean muscle scores and p-values for significant differences between males and females buried with and without grave goods in Neresheim (using independent samples t-test)

Burial group		NE M * NE F: LL			
		all	**YA**	**MA**	**OA**
GG	**MMS [a]**	0.40 * 0.27	0.09 * 0.00	0.23 * 0.27	0.53 * 0.43
	p - value	NS	ND	NS	NS
no GG	**MMS [a]**	0.66 * 0.34	ND	ND * 0.18	0.66 * 0.59
	p - value	NS	ND	ND	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = NE M, second value = NE F

By and large, the results of this analysis comply with findings made previously regarding the burial groups for males and females as well as for the two populations: with few exceptions, individuals buried without GG show greater indications of entheseal alteration over the life course than individuals buried with GG, and males exhibit higher prevalences of EC than females. Importantly, however, certain differences between the burial groups did emerge which had been concealed before:

- Males buried with GG at Neresheim exhibit a more significant increase of entheseal alteration of UL and LL than is discernible in males buried without GG, which may present a clue to what could be observed in the comparative display of EC prevalence and find frequencies (Fig. 7.59).
- Males and females buried with GG at Pleidelsheim show no evidence of EC in the UL during young adulthood; while comparative data for YA females buried without GG are absent (although previous analyses have resulted in the absence of observable EC in YA females at Pleidelsheim altogether, cf. Chapter

7.1.3.3), it is noteworthy that YA males buried without GG show a comparatively high prevalence of both minor and major EC in the UL.

- Despite a general preponderance of EC in individuals at Neresheim, males buried without GG at Pleidelsheim show a higher prevalence of EC in UL and LL than males in the same burial group at Neresheim; in the UL, females display a similar tendency.

The lack of significant differences between the burial groups as well as a positive relationship between find frequencies and the occurrence of EC suggests that whether an individual was found buried with GG or not, levels and patterns of activity do not differ to a significant degree at Pleidelsheim and Neresheim.

7.2.2 Correlations of entheseal changes and grave inclusions

In order to investigate the potential use of artefacts found in the burials and a possible reflection in the skeletal remains of activity patterns that may involve their use, selected artefacts were correlated with the absence or presence of EC in the UL. The choice of AT (partially following suggestions by Molnar 2010) for this analysis was determined by:

1) the artefact occurring twice or more at both Pleidelsheim and Neresheim,
2) the sum of artefacts of one type presenting a sample size suitable for statistical analysis,
3) the type of artefact suggesting a regular or frequent use, presenting or contributing to habitual activity that could potentially lead to heightened physical strain on the muscles and their entheses analysed in this study.

Due to the customary finding of weapons in male burials as well as tools of the textile production in female burials leading to the identification of gendered 'occupations' or activities during life, sword, lance and axe, as well as a combination of them, were tested for a correlation with EC, while with regard to female artefacts, spindle whorls and weaving swords were selected for this analysis, in each grave each object counting as one. Although potentially providing interesting indications of an actual use, the numbers for horse riding-related GG (snaffle and harness, spurs) were too small for statistical analysis; therefore, this examination focuses on EC in the UL.

Table 7.28 lists the numbers of individuals and artefacts observable for this analysis.

Table 7.28: Number of artefacts for males and females from Pleidelsheim and Neresheim available for correlation with EC

Artefact	Pleidelsheim		Neresheim	
	M (n = 78)	F (n = 84)	M (n = 41)	F (n = 79)
sword	8	-	6	-
lance	19	-	4	-
sword + lance	5	-	2	-
axe	7	-	0	-
spindle whorl	-	17	-	6
spindle whorl + weaving sword	-	1	-	0

Considering the solitary occurrence of a weaving sword in the female sample from Pleidelsheim, this will be summarized in the observation 'spindle whorl / weaving sword' in the following analysis.

7.2.2.1 Male burials

Table 7.29 lists the results of testing a potential correlation between the artefacts sword, lance, the combined occurrence of sword and lance in a burial, as well as axe, and the presence of EC observed in the UL of males who were found buried with these artefacts at Pleidelsheim.

Table 7.29: Pleidelsheim - Correlation of archaeological burial artefacts and MSM in male burials

UL enthesis	sword p-value a)		lance p-value a)		sword + lance p-value a)		axe p-value a)	
	R	L	R	L	R	L	R	L
HSC	NS	NS	NS	NS	NS	NS	NS	NS
HSI	NS	NS	NS	NS	NS	NS	NS	NS
HEM	NS	NS	NS	NS	NS	NS	NS	NS
HEL	NS	NS	NS	.011*	NS	NS	NS	NS
RBB	NS	NS	NS	NS	NS	NS	NS	.012*
UTB	NS	NS	NS	NS	NS	NS	NS	NS
HGP	NS	NS	NS	NS	NS	NS	NS	NS
HDE	NS	NS	NS	NS	NS	NS	NS	NS
RRP	NS	NS	NS	NS	NS	NS	NS	NS

[a)] Spearman's Rank Correlation Coefficient: *correlation is significant at the 0.05 level 92-tailed); **correlation is significant at the 0.01 level (2-tailed).

Notes on significant results:

Relationship	Significance	Comments
*Lance * entheseal changes*		
HEL L	ρ = -.474, N = 28	inverse relationship
*Axe * entheseal changes*		
RBB L	ρ = .450, N = 30	positive correlation

In the majority of cases, no significant correlation could be detected. In two instances, however, a significant relationship between the presence of an artefact and EC to the UL exists:

- Males at Pleidelsheim show an inverse relationship between the grave inclusion of a lance and EC to the attachment of the common extensor muscles at the left distal humerus (HEL L; Table 7.29). While changes to a variety of other entheses are observable in males buried with a lance, none of them show EC to the lateral epicondyle of the left humerus. This observation is independent of age, as the male individuals buried with lances are found across all age categories, with the majority in young middle adulthood (cf. Chapter 5.3.1, Table 5.24). As observed before, this enthesis only shows changes in males at Pleidelsheim from middle adulthood onwards and a steep increase with old adulthood (cf. Fig. 7.37), and the common extensors are not found among the highest-ranking muscles in this group. The active motion of using a lance would potentially involve the rotator cuff muscles of the shoulder (shoulder stabilisation), the biceps and triceps muscles for flexion and extension of the elbow of the throwing or stabbing limb, and, as demonstrated by studies on javelin throwers[107], changes to the enthesis for the flexors at the medial epicondyle of the humerus (Miller 1960 ; Dutour 2000). Among the males buried with a lance at Pleidelsheim, EC at Mm. medial epicondyle could not be observed at all. Only one YMA male (Skel. 245; cf. App. 5, Table 11) exhibits EC at Mm. lateral epicondyle of the right humerus. He was found buried in a 'simple' grave, with seax and lance as the only items of weaponry, and furthermore shows major EC caused by the right *M. supra- and infraspinatus* and *M. pectoralis major*, as well as minor EC to the left *M. pectoralis major* and right *M. biceps brachii*. This combination of MSM does not, however, point to the habitual or strenuous use of a lance but may be related to a whole range of activities exerted, given the occurrence of all but one entheses among the most highly altered ones for males at Pleidelsheim (cf. Table 7.1). As no positive correlation could be uncovered between EC to Mm. medial epicondyle and the presence of a lance as GG, an inverse relationship between the lateral extensors, acting as antagonists to the flexors, and the GG 'lance' does not provide a converse argument for the potential use of a lance in this sample.

- A positive correlation could be detected between EC to the left *M. biceps brachii* attachment and the presence of an axe within male burials (Table 7.29). While a relationship between the motion employed to use an axe and the development of EC caused by frequent and / or heavy use of the left biceps muscle is entirely possible, the utilization of an axe may take on various forms

[107] Although throwing a lance would not be the same motion as using it as a stabbing weapon, the muscles involved would act in a similar way, albeit with less dynamic capacity.

that involve elbow flexion and forearm supination, as do many other activities that do not relate to axe use, also considering the occurrence of *M. biceps brachii* among the highest-ranking muscles in Pleidelsheim males (cf. Table 7.1).

Sample sizes for males at Neresheim are too small for meaningful analysis and provide fewer than five examples in all instances, except for the group buried with a sword (Table 7.28). A positive correlation was found between the presence of a sword in the burial and EC to the right *Mm. supra- and infraspinatus* (Table 7.30). However, the small sample size (n = 6) does not allow further interpretation from this finding, other than that the abduction and lateral rotation that is effected by this muscle group may very well be involved in the movement required to operate a sword, which would, among others, involve the heavy use of the shoulder (e.g. (Knüsel 2000a). In males at Neresheim, this muscle attachment does not occur among those indicating the highly scoring muscles, but is one that shows osseous changes with an onset during young adulthood (cf. Table 7.7).

Table 7.30: Neresheim - Correlation of archaeological burial artefacts and MSM in male burials

UL enthesis	sword p-value a)		lance p-value a)		sword + lance p-value a)	
	R	L	R	L	R	L
HSC	NS	NS	NS	ND	NS	ND
HSI	.030*	ND	ND	ND	ND	ND
HEM	NS	ND	NS	ND	NS	ND
HEL	NS	ND	NS	ND	NS	ND
RBB	NS	NS	NS	NS	NS	ND
UTB	NS	NS	NS	NS	NS	NS
HGP	NS	NS	NS	ND	NS	ND
HDE	NS	NS	NS	NS	NS	NS
RRP	NS	NS	NS	NS	NS	NS

a) Spearman's Rank Correlation Coefficient: *correlation is significant at the 0.05 level 92-tailed); **correlation is significant at the 0.01 level (2-tailed).

Notes on significant results:

Relationship	Significance	Comments
*Sword * entheseal changes*		
HSI R	ρ = .756, N = 8	positive correlation

7.2.2.2 Female burials

Table 7.31 displays the results of the correlation analysis for a relationship between the presence of tools of textile manufacturing (spindle whorl and weaving sword) and of EC to the UL in females at Pleidelsheim and Neresheim. While for females at Neresheim, the evidence for these grave inclusions is scant (Table 7.28), the results were negative throughout for both populations (Table 7.31). As mentioned before with regard to extra-vertebral DJD (cf. Chapter 6.1.2.4), the habitual movement required for spinning and weaving would exert mechanical stress on the entheses of extensors and flexors of the right and left hands and fingers, possibly in combination with stress distributed onto the UL entheses overall.

Table 7.31: Correlation of archaeological burial artefacts and MSM in female burials

UL enthesis	PH F spindle whorl / weaving sword p-value [a)]		NE F spindle whorl / weaving sword p-value [a)]	
	R	L	R	L
HSC	NS	NS	ND	NS
HSI	NS	NS	ND	ND
HEM	ND	NS	NS	NS
HEL	NS	NS	NS	NS
RBB	NS	NS	NS	NS
UTB	NS	NS	NS	ND
HGP	NS	NS	ND	NS
HDE	NS	NS	NS	NS
RRP	NS	NS	NS	ND

[a)] Spearman's Rank Correlation Coefficient: *correlation is significant at the 0.05 level 92-tailed); **correlation is significant at the 0.01 level (2-tailed).

None of the females at Pleidelsheim or Neresheim showed corresponding osseous changes of the entheses of any of the involved muscles. Furthermore, at Pleidelsheim, there was a tendency for an inverse relationship of changes to the left *M. deltoideus* enthesis ($\rho = -.272$, $p = .058$, $N = 49$), thus a potential correlation of physical and material evidence for these artefacts would trend towards the opposite of what could be expected, if these objects had been used habitually. Yet these negative findings correspond with what could be observed before with regard to females at Pleidelsheim - the complete absence of DJD to the wrists and hands (cf. Chapter 6.1.2.4) that might be connected with habitual, strenuous activity using these limbs.

As EC form only part of the potentially activity-related changes observed with regard to possible activities of individuals, it was not expected to confirm or refute the habitual use of the items found in their graves. However, the present results provide some indications towards these questions, and it is plausible to suggest that there are differences at least in the case of the male populations with regard to the use of weaponry found in their burials. At Neresheim, males may have indeed used swords and were buried with this artefact[108], while at Pleidelsheim, there is growing evidence for the opposite, with few indications of activity-related changes connected with the actual use of weaponry by males in the burial group 'M W'.

7.3 Weapon burials - Evidence of activity

In the light of present results, considering activity-related skeletal changes as well as the identification and distinction of the burial group 'M W' (males with weapons), it is of interest to explore whether the analysis of EC permits insight into the question of whether males interred in weapon burials were actively and habitually using weapons, i.e. in more general terms, whether the males found with weapons in Alamannic cemeteries were the reputed warriors of Alamannic society. In order to complement the findings made earlier with regard to archaeological and skeletal data, and to investigate EC in males from Pleidelsheim and Neresheim, this analysis will consider the following questions:

- Is there a significant difference, in any given age category, with regard to the prevalence of EC between the burial groups 'M W' (males buried with weapons) and 'M NW' (males buried without weapons)?
- Is a differing use of certain muscles distinguishable, and if so, which muscles were used preferentially by individuals of a particular burial group?

[108] I.e. they must not necessarily have used *the* sword that they were buried with.

The latter question includes the analysis for patterns of EC that may potentially relate to changes to muscle attachments inflicted by frequent or strenuous weapon use. As the presence of weaponry in a grave denotes a 'weapon burial', all burials with determinable biological age and sex could be included in this investigation, increasing the sample sizes of weapon burials available for examination.

7.3.1 Prevalence of entheseal changes in weapon burials

7.3.1.1 Upper limb

The patterns of EC prevalence and its association with age observed in the burial groups 'M W' and 'M NW' at Pleidelsheim and Neresheim (App. 7, Tables 22 - 25) seem to reflect the general observations made when examining the burial groups 'M GG' and 'M NGG' (cf. Chapter 7.2.1.2). However, some differences are distinguishable which set the burial group 'M W' apart from the others with regard to osseous changes of muscular entheses.

For the group 'M W' at both sites, Pleidelsheim and Neresheim, a continuous increase of EC with age in the UL is observable, albeit for this burial group with a statistically significant difference in the Pleidelsheim sample only, between OA males as opposed to younger males buried with weapons, and YA males not showing any indications for EC in the UL (Table 7.32). This age-related increase of EC is accompanied by a considerable accruement of major EC (score C, Fig. 7.70) from middle to old adulthood. No significant difference regarding the presence of muscle markings in males of any age category could be observed in the burial group 'M NW'

(Table 7.32), yet it is noteworthy that males buried without weapons do not only show minor and major EC throughout life, with an overall increase with age, but a higher (at Pleidelsheim) or comparable (at Neresheim) prevalence of major EC at young than at middle adulthood (Fig. 7.71; Fig. 7.73).

Table 7.32: Total UL MSM mean muscle scores and p-values for significant differences between the three age categories (using χ^2) for males buried with and without weaponry in the two sites of Pleidelsheim and Neresheim

Site			M with weapons (M W)			M without weapons (M NW)		
			YAM	**MAM**	**OAM**	**YAM**	**MAM**	**OAM**
Pleidelsheim W: n=44 NW: n=34	**MMS**		0.00	0.23	0.54	0.23	0.25	0.65
	p - value	YA		NS			NS	
		MA	NS		.047*	NS		NS
Neresheim W: n=11 NW: n=30	**MMS**		0.08	0.00	0.42	0.44	0.36	0.54
	p - value	YA		NS			NS	
		MA	NS		NS	NS		NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

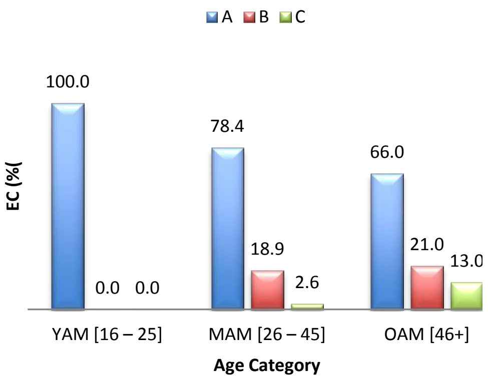


Fig. 7.70: Pleidelsheim: Prevalence of EC - M W, UL

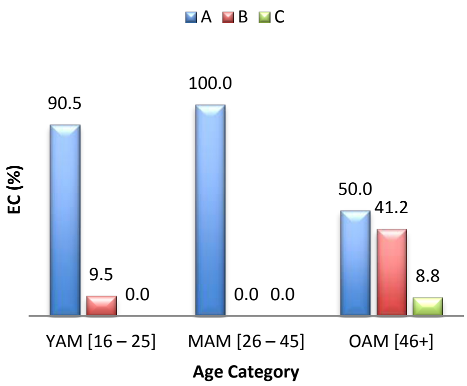


Fig. 7.72: Neresheim: Prevalence of EC - M W, UL

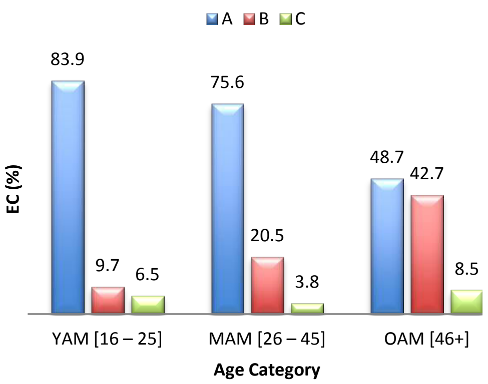


Fig. 7.71: Pleidelsheim: Prevalence of EC - M NW, UL

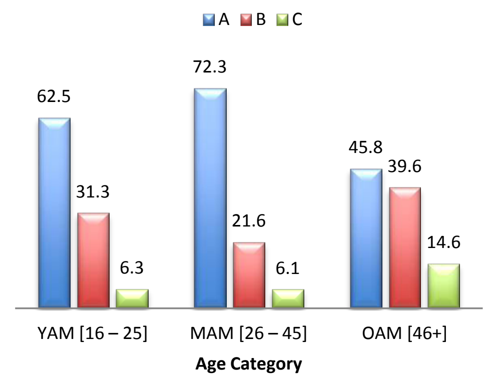


Fig. 7.73: Neresheim: Prevalence of EC - M NW, UL

In the comparison of MMS of M W versus M NW (Table 7.33), those individuals buried without weapons show a generally higher number of EC than those buried with weapons, a reflection of what could be detected in the burial groups 'M GG' and 'M NGG' (cf. Table 7.13). However, the differences between weapon burials and those without weaponry become statistically significant in two cases that do not include the substantial influence of age that must be considered for EC during old adulthood[109]. At Pleidelsheim, YA males buried with weapons do not show EC in the UL, which constitutes a significant difference to those buried without items of weaponry, a difference that is levelled when reaching middle adulthood (Table 7.33). At Neresheim, males who died in middle adulthood and were interred with weapons display no evidence of EC of the UL, in stark contrast to males in the same age category found without weapons (Table 7.33).

Table 7.33: Total UL MSM mean muscle scores and p-values for significant differences between the two groups (using independent samples t-test) for males buried with and without weaponry in the two sites of Pleidelsheim and Neresheim

Site		M W * M N W: UL			
		all M	**YAM**	**MAM**	**OAM**
Pleidelsheim	**MMS [a]**	0.31 * 0.47	0.00 * 0.19	0.23 * 0.25	0.54 * 0.65
n=78	**p - value**	NS	.026*	NS	NS
Neresheim	**MMS [a]**	0.23 * 0.44	0.08 * 0.44	0.00 * 0.36	0.42 * 0.54
n=41	**p - value**	NS	NS	.000**	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = M W, second value = M N W

Considering the findings regarding patterns of skeletal health (cf. Chapter 6.3), this complements these results, with M NW in general showing a higher rate of physical stress indicators than M W (cf. Chapter 6.3.3, Table 6.69). Considering the findings regarding the distribution of burial artefacts, i.e. weaponry, the data obtained from the examination of muscular UL entheses raise questions on the potential actual

[109] However, small sample sizes may influence the observations, which therefore can only be considered indicative and would need substantiation by the analysis of larger cemetery samples.

use of weapons: at Pleidelsheim, the skeletal evidence could not detect any clear, positive relationship between the presence of weapons in a burial and their frequent use by the individual interred with them, and the combination of artefactual and anthropological data indicates a differentiation of the group ‘M W’ from other burial groups, which is, however, neither very distinctive (cf. Chapter 6.3.3) nor directly related to social status as expressed by weapon accoutrement (cf. Chapter 5.3). At Neresheim, minor EC could be observed in M GG in the MA category (cf. Fig. 7.62), yet none are traceable in the same age category for the group ‘M W’ (Fig. 7.72). Interestingly, middle adulthood comprises those age categories (YMA, OMA, with the addition of MTA) in which, exclusively, sword, shield or lance occur in the graves of males at Neresheim (cf. Chapter 5.3.1).

Between the groups ‘M NW’ at Pleidelsheim and Neresheim, there is hardly any difference recognizable regarding the UL MMS (Table 7.34; Fig. 7.74). Where no data could be provided in the analysis of YA and MA males buried without GG at Neresheim (cf. Table 7.14), males buried without weapons at Neresheim show higher prevalences of UL EC than those at Pleidelsheim (Table 7.34; Fig. 7.74). In the groups ‘M W’, differences between both populations are more notable. While M GG at Neresheim showed an overall higher UL MMS than M GG at Pleidelsheim (cf. Table 7.14), M W at Neresheim seem to display a generally lower MMS than those at Pleidelsheim, a result, however, largely due to the lack of observable EC in MA males at Neresheim (Table 7.34). Although sample sizes must be increased for a more informed assessment, males from Neresheim buried with weapons show an earlier onset of EC in the UL than males buried with weapons at Pleidelsheim (Fig. 7.74).

Table 7.34: Inter-population comparison. Total UL MSM mean muscle scores and p-values for significant differences between males buried with and without weaponry in the two sites of Pleidelsheim and Neresheim (using independent samples t-test)

		PH M * NE M: UL			
		all M	**YAM**	**MAM**	**OAM**
weapons (M W)	**MMS [a]**	0.31 * 0.23	0.00 * 0.08	0.23 * 0.00	0.54 * 0.42
	p - value	NS	NS	.001**	NS
no weapons (M NW)	**MMS [a]**	0.47 * 0.44	0.23 * 0.44	0.25 * 0.36	0.65 * 0.54
	p - value	NS	NS	NS	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH M, second value = NE M

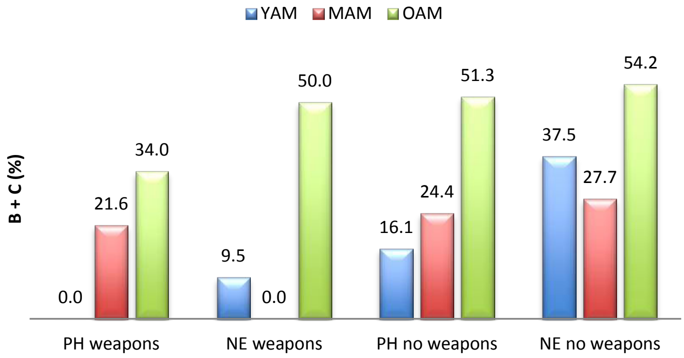


Fig. 7.74: Inter-population comparison: Prevalence of EC - M W and M NW, UL

7.3.1.2 Lower limb

Considering the LL, patterns of overall prevalence of EC in M W and M NW at Pleidelsheim largely agree with the observations made in the analysis of M GG and M NGG (cf. Fig. 7.64; Fig. 7.65), with a continuous increase of minor and major EC with age in the group 'M W' (Fig. 7.75) and considerably more major EC at young adulthood, compared to middle adulthood, and overall in relation to old adulthood in the group 'M NW' (Table 7.35; Fig. 7.76). Males buried with weapons at Neresheim present uniform patterns to the burial group 'M GG' (cf. Table 7.20), with the peculiarity of a notable increase in major EC with old age in M W, as opposed to a more moderate accumulation of minor and major EC in M GG (Fig.

7.77; cf. Fig. 7.66). A steady increase of LL EC with age is observable in the group 'M NW' (Table 7.35), however, also here the comparatively high MMS in M W as opposed to M NW at old adulthood is noteworthy (Fig. 7.77; Fig. 7.78).

Table 7.35: Total LL MSM mean muscle scores and p-values for significant differences between the three age categories (using χ^2) for males buried with and without weaponry in the two sites of Pleidelsheim and Neresheim

Site			M with weapons (M W)			M without weapons (M NW)		
			YAM	MAM	OAM	YAM	MAM	OAM
Pleidelsheim W: n=44 NW: n=34	**MMS**		0.11	0.39	0.58	0.40	0.19	0.72
	p - value	YA		NS			.000**	
		MA	NS		NS	.000**		NS
Neresheim W: n=11 NW: n=30	**MMS**		0.05	0.00	0.76	0.14	0.36	0.60
	p - value	YA		NS			NS	
		MA	NS		.009**	NS		.014*

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level

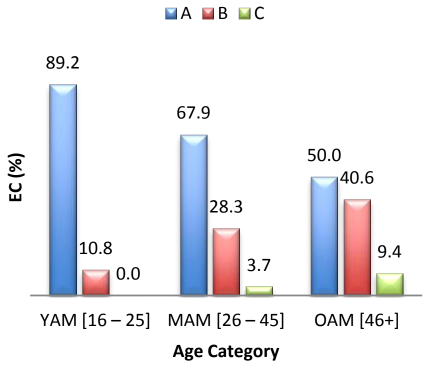


Fig. 7.75: Pleidelsheim: Prevalence of EC - M W, LL

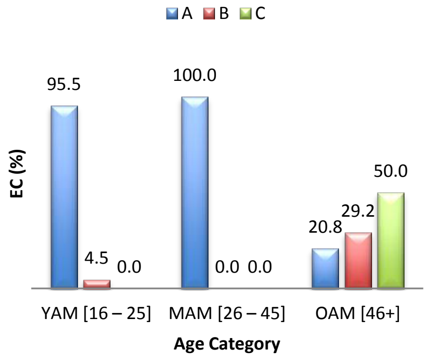


Fig. 7.77: Neresheim: Prevalence of EC - M W, LL

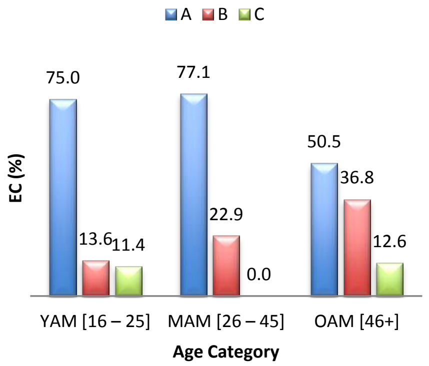


Fig. 7.76: Pleidelsheim: Prevalence of EC - M NW, LL

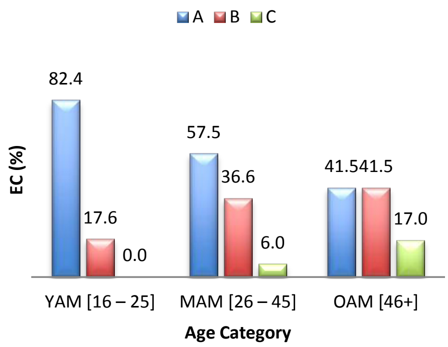


Fig. 7.78: Neresheim: Prevalence of EC - M NW, LL

The comparison of LL EC in M W and M NW resulted in almost equal overall MMS values for both groups at both sites, and in no statistically significant difference between the burial groups in any age category except for MA males at Neresheim (Table 7.36). Notably, in this group, M W also display no EC in the LL, in contrast to M GG (cf. Fig. 7.66), as well as to M NW.

Table 7.36: Total LL MSM mean muscle scores and p-values for significant differences between the two groups (using independent samples t-test) for males buried with and without weaponry in the two sites of Pleidelsheim and Neresheim

Site		**M W * M N W: LL**			
		all M	**YAM**	**MAM**	**OAM**
Pleidelsheim n=78	**MMS [a]**	0.42 *0.48	0.11 * 0.40	0.39 * 0.19	0.58 * 0.72
	p - value	NS	NS	NS	NS
Neresheim n=41	**MMS [a]**	0.43 * 0.45	0.05 * 0.14	0.00 * 0.36	0.76 * 0.60
	p - value	NS	NS	.002**	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = M W, second value = M N W

This also leads to the only detectable significant difference in the inter-population comparison of LL EC in weapon burials (Table 7.37). Overall, all 'weapon burial groups' demonstrate similar overall MMS, which differ from the findings for M N GG, a group showing considerably higher prevalences of LL EC in males from Pleidelsheim than from Neresheim (cf. Table 7.22). The only significant difference can be observed in the MA category (Table 7.37), where Pleidelsheim M W show evidence of both minor and major EC to the LL (Fig. 7.75), a disparity reversed during old adulthood.

Table 7.37: Inter-population comparison. Total LL MSM mean muscle scores and p-values for significant differences between males buried with and without weaponry in the two sites of Pleidelsheim and Neresheim (using independent samples t-test)

		PH M * NE M: LL			
		all M	**YAM**	**MAM**	**OAM**
weapons	**MMS [a]**	0.42 * 0.43	0.11 * 0.05	0.39 * 0.00	0.58 * 0.76
(M W)	**p - value**	NS	NS	.001**	NS
no weapons	**MMS [a]**	0.48 * 0.45	0.40 * 0.14	0.19 * 0.36	0.72 * 0.60
(M NW)	**p - value**	NS	NS	NS	NS

YA = young adult, MA = middle adult, OA = old adult; NS = not significant; ND = no data; *significance at p<.05 level, **significance at p<.01 level; [a] first value = PH M, second value = NE M

7.3.2 Patterns of entheseal changes and muscle use in weapon burials

7.3.2.1 Pleidelsheim

a) Upper limb

The consideration of patterns differential entheseal alterations provides insight into variations in weapon burials. At Pleidelsheim, a higher prevalence of EC of the UL are suggested for M NW, however, with a difference not significant on the general level (Table 7.33). This is reflected in the analysis of individual entheses, with three entheses showing statistically significantly more changes in M NW than in M W (App. 7, Table 26): the right *M. pronator teres* as well as the left common lateral extensors and flexors (Fig. 7.79). This elucidates the observation of an inverse relationship between EC to the left Mm. lateral epicondyle (HEL L) and the burial accoutrement of a lance (cf. Chapter 7.2.2.1), as this enthesis is significantly more highly affected in M NW, and does not seem to bear great importance in the patterns of muscle use in M W, as the rank order profile shows (Fig. 7.79). Bilaterally, Mm. lateral epicondyle, *M. subscapularis*, and *M. biceps brachii*, as well as the left *M. supra- and infraspinatus* present the highest-ranking muscles in M NW (App. 7, Table 26), while in M W, only the biceps, subscapularis and pectoralis muscles are found within this range (App. 7, Table 26; Fig. 7.79). This indicates a greater variation in entheseal alterations in males buried without weapons, while males buried with weapons show no difference in rank ordering to males at Pleidelsheim in general (cf. Table 7.1). A test for positive functional relationships between the highest-ranking muscles in M W resulted in a strong correlation between changes at *M. biceps brachii* with those noted at *M. subscapularis* in the right UL (ρ = .516, N = 16, p = .041*), as well as the left UL (ρ = .661, N = 15, p = .007**), while none could be detected for these muscles with M. pectoralis major, or for any of the highest-ranking muscles in M NW.

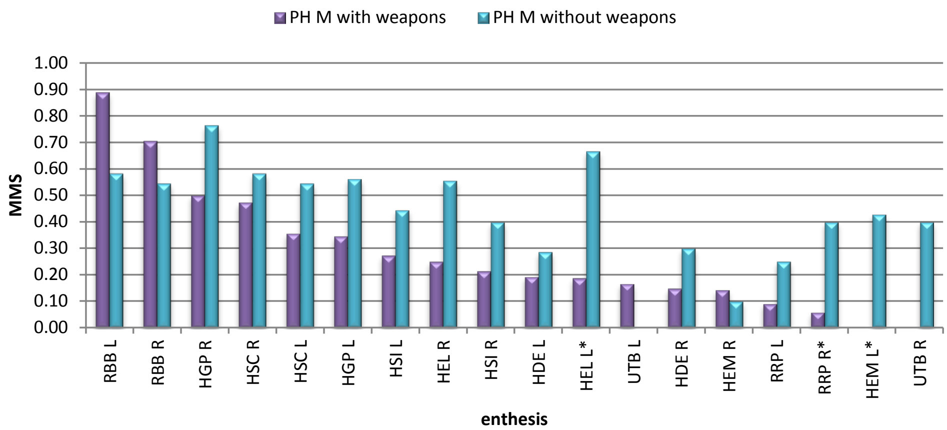


Fig. 7.79: Comparison of MMS of PH M W UL and PH M NW UL, with PH M W as the leading group. Entheses showing a statistically significant difference in entheseal change are marked with */**.

The analysis for relative population-based effects between the two burial groups revealed distinctly more highly expressed changes of the common flexors of the right hand and fingers (HEM R), *M. biceps brachii* as well as the left *M. triceps brachii* in M W (Fig. 7.80).

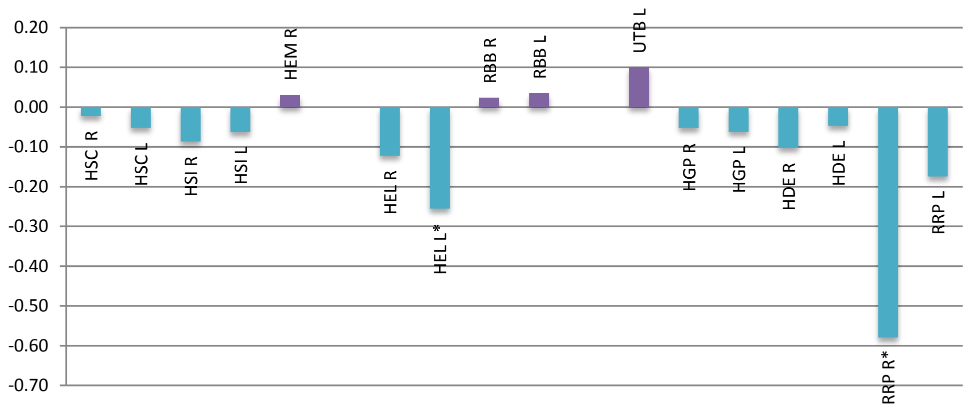


Fig. 7.80: Relative dimorphism of UL entheses between M W and M NW at Pleidelsheim (expressed as absolute differences between MMS for every enthesis, in all males; muscles with a positive value have higher rank ordering in PH M W)

However, as noted before, no UL EC can be discerned in M W during young adulthood (Fig. 7.81; cf. App. 7, Table 22). Thus, greater changes noted at *M. biceps* *brachii* and the muscles of the medial epicondyle of the right distal humerus can only be observed from middle adulthood onwards in M W (Fig. 7.81), contrary to M NW who only show osseous changes to these entheses in the OA category (Fig. 7.82).

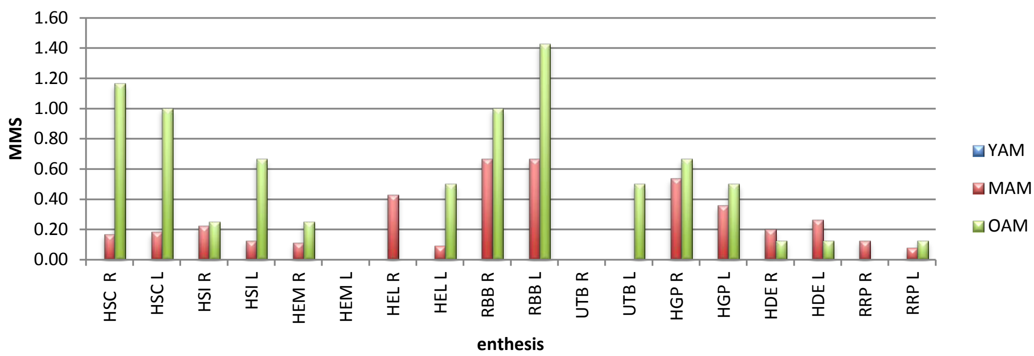


Fig. 7.81: Relationship of MMS with age: Pleidelsheim M W, UL

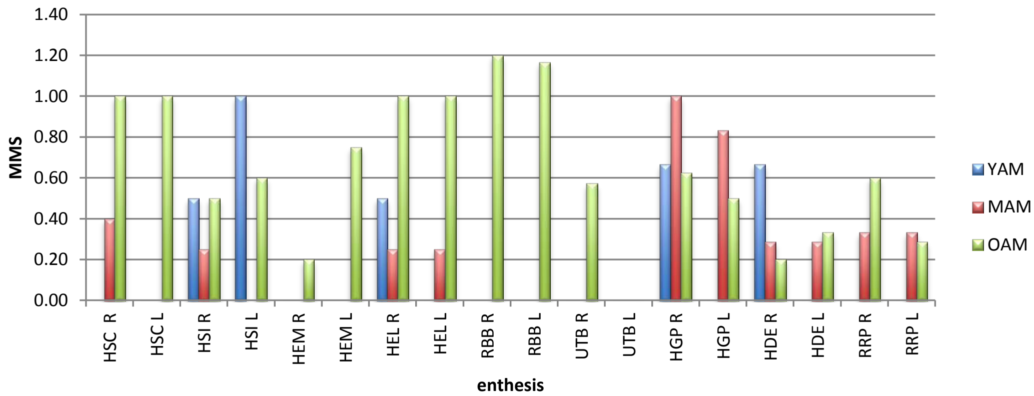


Fig. 7.82: Relationship of MMS with age: Pleidelsheim M NW, UL

The picture of differential muscle effects in males during middle adulthood (Fig. 7.83) is slightly different from that presented when observing the entire male population (Fig. 7.80), as muscles forming the left rotator cuffs (HSI, HSC) as well as the extensors attaching to the lateral epicondyle of the right humerus (HEL) can be added to those muscles which have higher scores in males buried with weapons during this stage of life, with changes to the entheses of the Mm. lateral epicondyle being *solely* observable during middle adulthood in M W (Fig. 7.81). Therefore, despite an overall almost identical MMS for MA males with and without weapons at Pleidelsheim (cf. Table 7.33) and no recognizable difference in MMS between the two burial groups in their sum total, differential patterns of use can be suggested with regard to these data, during an age in which entheses are not yet as heavily influenced by age-related, degenerative changes as during old adulthood.

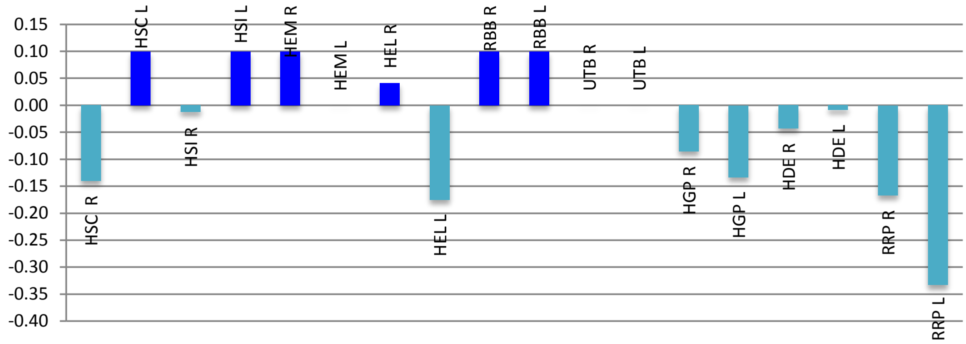


Fig. 7.83: Relative dimorphism of UL entheses between PH M W and PH M NW during middle adulthood (expressed as absolute differences between MMS for every enthesis, in all MA males; muscles with a positive value have higher rank ordering in PH M W)

b) Lower limb

As observed previously for the aggregate of LL MMS (cf. Table 7.36), no significant difference could be discerned between M W and M NW at Pleidelsheim, overall and in any age category, and the observation of changes to individual entheses resulted in only one displaying a significant difference, the right side attachment of *M. gluteus minimus* (Fig. 7.84; App. 7, Table 26). The strongest changes to muscular entheses in M W can be observed for *M. gluteus maximus* and *M. iliopsoas* (bilaterally), as well as right *M. gluteus minimus* and *M. soleus* (App. 7, Table 26; Fig. 7.84). Changes of the entheses of *M. gluteus maximus* and *M. soleus* are also common to M NW; further, this burial group shows the highest prevalences of EC for the Achilles tendons and the muscles of the left posterior and anterior thigh (CSB and PQF L; App. 7, Table 26). Once again, the variety of most highly scoring muscles is greater in M NW, and LL EC observed in the group 'M W' fall within the range of highest-ranking LL muscles for males at Pleidelsheim in general (cf. Table 7.1).

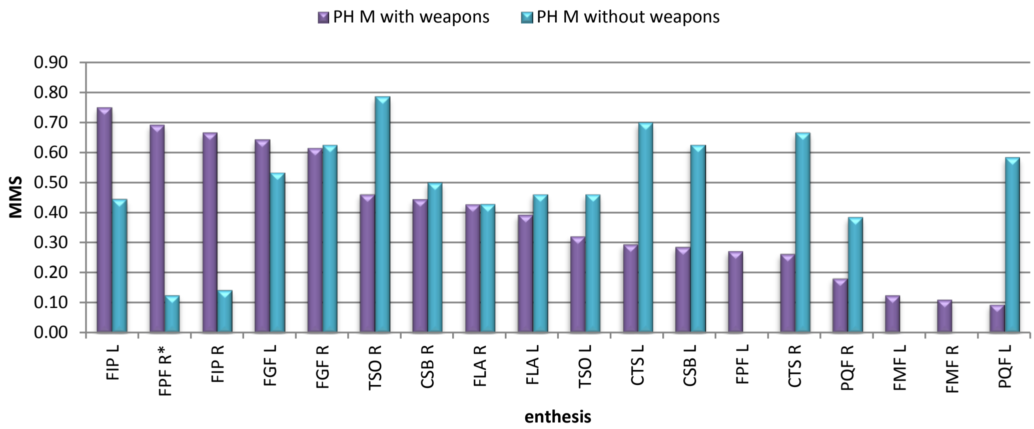


Fig. 7.84: Comparison of PH M W LL and PH M NW LL, with PH M W as the leading group. Entheses showing a statistically significant difference in entheseal change are marked with */**.

Examining distinctive differences in LL muscle use between the two groups reveals that entirely different muscle groups are affected most frequently in M NW compared to M W, i.e. especially *Mm. quadriceps femoris*, the hamstrings (CSB), *Mm. triceps surae* as well as *M. soleus*. In M W, the focus shifts to the gluteal muscles and *M. iliopsoas*, suggesting a differentiated, albeit not statistically significantly difference in entheseal change between the two burial groups at Pleidelsheim.

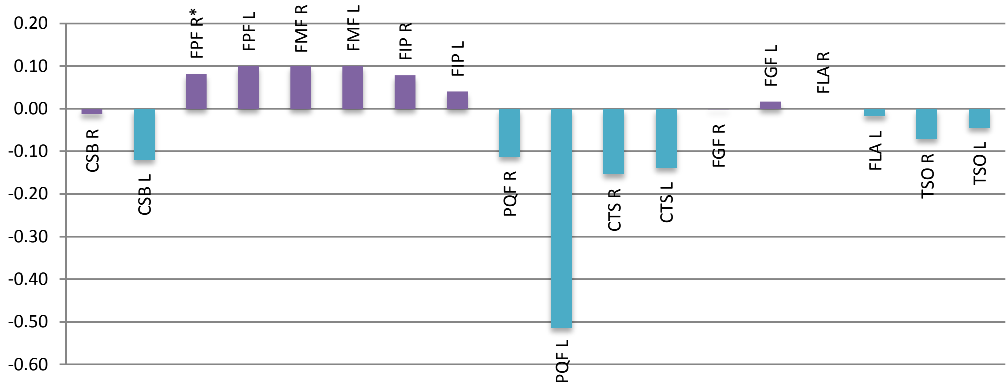


Fig. 7.85: Relative dimorphism of LL entheses between M W and M NW at Pleidelsheim (expressed as absolute differences between MMS for every enthesis, in all males; muscles with a positive value have higher rank ordering in PH M W)

As Fig. 7.86 and Fig. 7.87 demonstrate, the onset of EC at YA can be identified in a similar range of muscles in both burial groups, while the differentiation regarding LL muscle scores as shown above seems mainly connected with the age-related development of EC, given the development of LL EC in half of the examined muscle attachments in M NW only during old adulthood (Fig. 7.87).

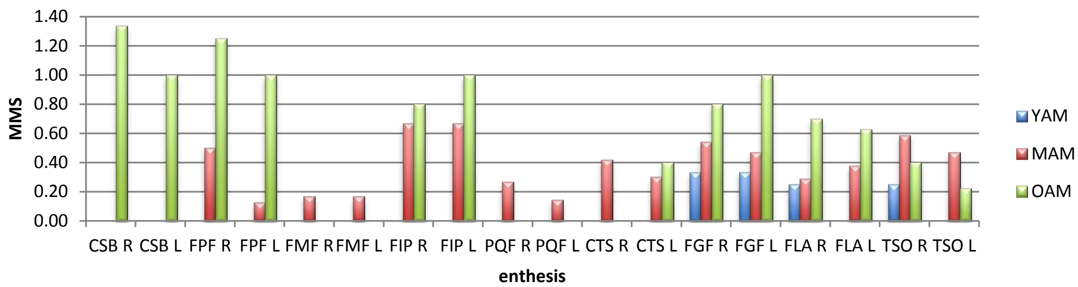


Fig. 7.86: Relationship of MMS with age: Pleidelsheim M W, LL

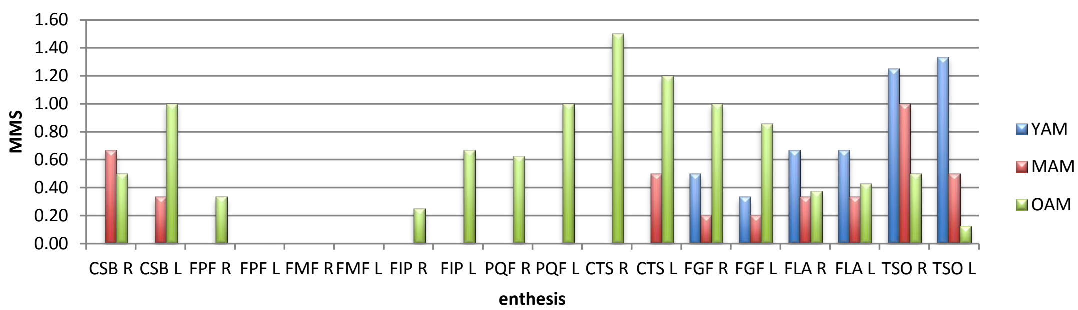


Fig. 7.87: Relationship of MMS with age: Pleidelsheim M NW, LL

7.3.2.2 Neresheim

a) Upper limb

Males buried without weapons show overall a higher prevalence of UL EC than males buried with weapons at Neresheim (cf. Table 7.33), however, the examination of individual UL entheses revealed only one statistically significant difference, with a notably higher presence of EC in the right *Mm. supra- and infraspinatus* in M W (Fig. 7.88; App. 7, Table 27). Moreover, the burial group 'M W' shows by far the greatest variation in muscle scores, as indicated by the range of highest-ranking MMS: discernible are *M. subscapularis* and *M. pectoralis major* (bilaterally), as well as, in the right UL, *Mm. supra- and infraspinatus*, the common flexors and extensors of the hand and fingers (HEM R, HEL R), *M. pronator teres*, *M. biceps* and *M. triceps brachii* (App., 5.3, Table 27; Fig. 7.88). In contrast, M NW display among their highest-ranking muscles precisely those which could be identified earlier as most affected in males at Neresheim in general (cf. Table 7.1), i.e. bilaterally, *M. biceps brachii*, *M. pectoralis*, and *M. subscapularis*, as well as the extensor muscles attaching on the lateral epicondyle of the left humerus (App. 7, Table 27).

The pronounced concentration of the greatest entheseal alteration of the muscles of the right UL in M W is emphasized by strong correlations found for certain groups of affected muscles, i.e. between the common extensors and flexors attaching at the right distal humerus (ρ = .854, N = 13, p = .000**), between the right common flexors and *M. subscapularis* (ρ = .791, N = 9, p = .011**) as well as *M. pectoralis major* (ρ = .556, N = 14, p = .039*), between the right common extensors and *M.*

biceps brachii (ρ = .791, N = 9, p = .011**), and lastly, between the common extensors of the right and left UL (HEL R and L, ρ = .745, N = 8, p = .034*).

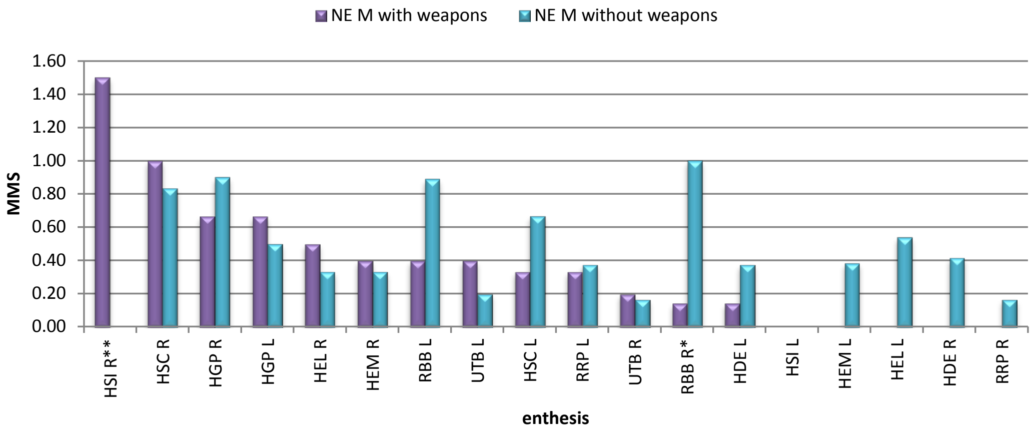


Fig. 7.88: Comparison of MMS of NE M W UL and NE M NW UL, with NE M W as the leading group. Entheses showing a statistically significant difference in entheseal change are marked with */**.

The concentration of changes of attachments of muscles of the right UL, already noted earlier for males at Neresheim in general (cf. Fig. 7.35, Chapter 7.1.3.2), remains strong in the analysis of relative population-based comparisons between M W and M NW, as M W display distinctly higher alterations in muscles forming part of the right rotator cuffs (HSC R, HSI R), the common flexors and extensors of the right hand and fingers, *M. triceps brachii* (bilaterally) as well as the left *M. pectoralis major* (Fig. 7.89).

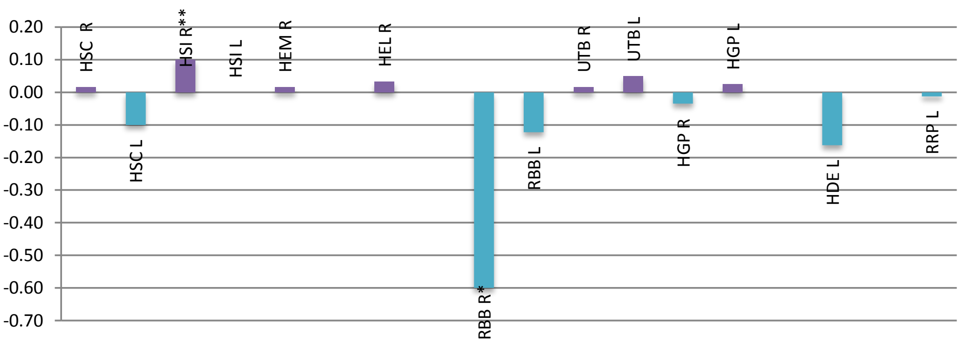


Fig. 7.89: Relative dimorphism of UL entheses between M W and M NW at Neresheim (expressed as absolute differences between MMS for every enthesis, in all males; muscles with a positive value have higher rank ordering in NE M W)

Both the left *M. pectoralis major* and right *Mm. supra- and infraspinatus* display osseous changes of their entheses already during young adulthood in M W (Fig. 7.90), which is completely at variance with patterns in M NW (Fig. 7.91). Due to the small sample size, the aforementioned positive correlations suggesting functional relationships between flexor and extensor muscles as well as other muscles of the right UL can at this point only be confirmed as occurring during old adulthood in M W (Fig. 7.90) and must therefore be considered to be of rather age-related character, moderating the significance of these findings, as a similar patterning cannot be automatically assumed for younger age categories.

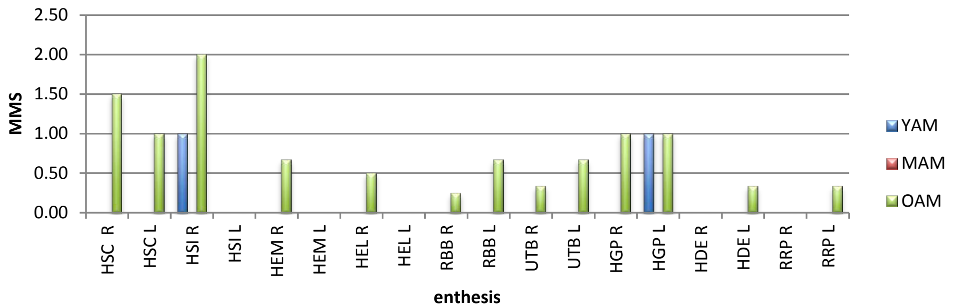


Fig. 7.90: Relationship of MMS with age: Neresheim M W, UL

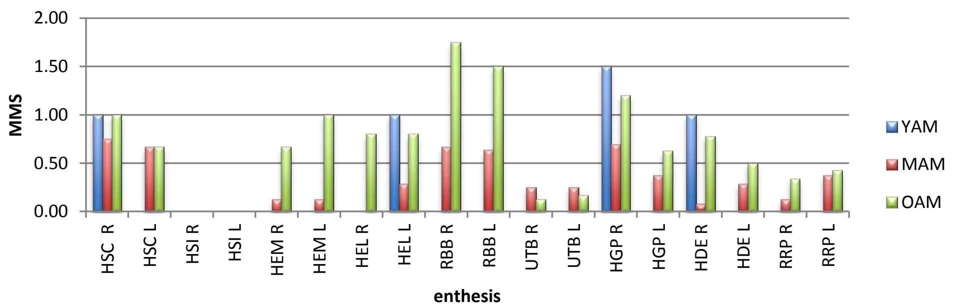


Fig. 7.91: Relationship of MMS with age: Neresheim M NW, UL

However, the enthesis for the right *Mm. supra- and infraspinatus*, which showed a positive correlation with the burial accoutrement sword (Table 7.30, Chapter 7.2.1.1), displays osseous changes only in M W at Neresheim, with an onset during young adulthood (Fig. 7.90), and is found among the highest-ranking muscle attachments in this burial group, contrary to the findings for males at Neresheim in general (cf. Table 7.7).

b) Lower limb

Following the observation of almost identical MMS for M W and M NW regarding LL EC at Neresheim (cf. Table 7.36), no significant differences could be found between males in the two burial groups with regard to individual entheses, even though a varied patterning of muscle effects appeared (Fig. 7.92). With the addition of the left *Mm. vastus and adductor* muscles (FLA L) and *M. gluteus minimus*, the range of highest scoring LL muscles in M W at Neresheim most closely resembles that of M NW at Pleidelsheim (i.e. muscles of the posterior and anterior thigh (CSB, PQF), however, bilaterally, *M. gluteus maximus* and the left Achilles tendon; Fig. 7.92). Males buried without weapons display the most changes to the entheses of left *M. iliopsoas* and *M. gluteus medius*, right Achilles tendon and *M. gluteus minimus*, as well as of the soleus muscles (App. 7, Table 27). Thus, M NW at Neresheim not only have reduced variation in the range of highest-ranking LL entheses, but also a pattern completely different from that displayed by M W (Fig. 7.92).

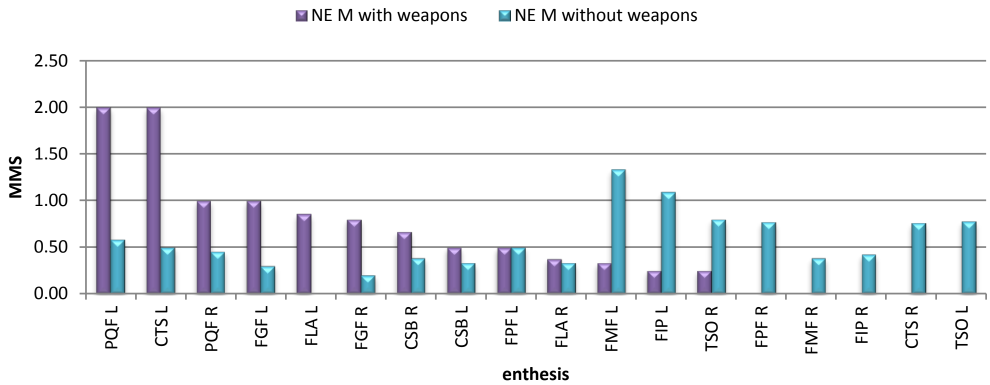


Fig. 7.92: Comparison of NE M W LL and NE M NW LL, with NE M W as the leading group. Entheses showing a statistically significant difference in entheseal change are marked with */**.

The analysis for population-based differences with regard to highly scoring entheses between the two burial groups (Fig. 7.93) merely supports these findings, as a significantly stronger expression of change is found for the left *M. iliopsoas* as well as the right *M. soleus*. The same applies to an examination of age-related changes of individual LL entheses, which did not yield noteworthy results towards a differentiation of the burial groups.

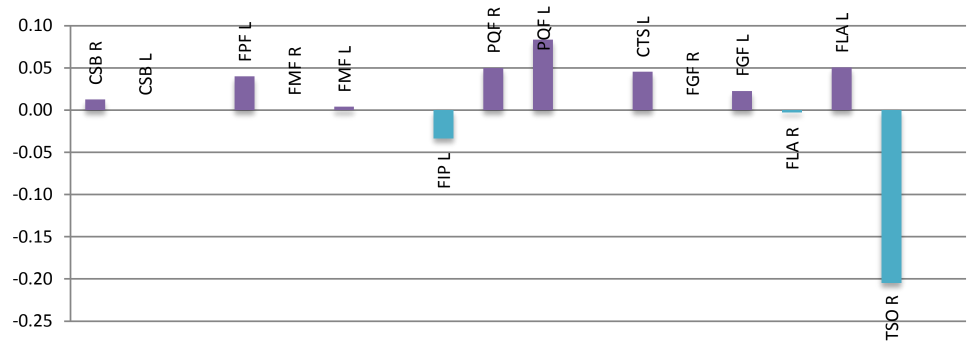


Fig. 7.93: Relative dimorphism of LL entheses between M W and M NW at Neresheim (expressed as absolute differences between MMS for every enthesis, in all males; muscles with a positive value have higher rank ordering in NE M W)

7.3.2.3 Inter-population comparison

With regard to a potential differentiation of the burial group 'M W' from other burial groups at Pleidelsheim and Neresheim, but also considering the emerging differences between males buried with weapons in both populations, an inter-population comparison of changes to individual entheses focuses on the burial group 'M W'.

a) Upper limb

Although males buried with weapons at Pleidelsheim showed moderately higher prevalences of EC to the UL than those at Neresheim (Table 7.34), a comparison of changes to individual entheses revealed only one case where a distinct difference is traceable, in the right *M. biceps brachii*, while M W at Neresheim also show significantly more changes to the enthesis of the right *Mm. supra- and infraspinatus* (Fig. 7.94; App. 7, Table 28). Moreover, it is discernible that M W at Neresheim also show more EC caused by the right *M. subscapularis*, the common flexors and extensors of the right hand, as well as, bilaterally, *M. pectoralis major* and *M. triceps brachii* (Fig. 7.94).

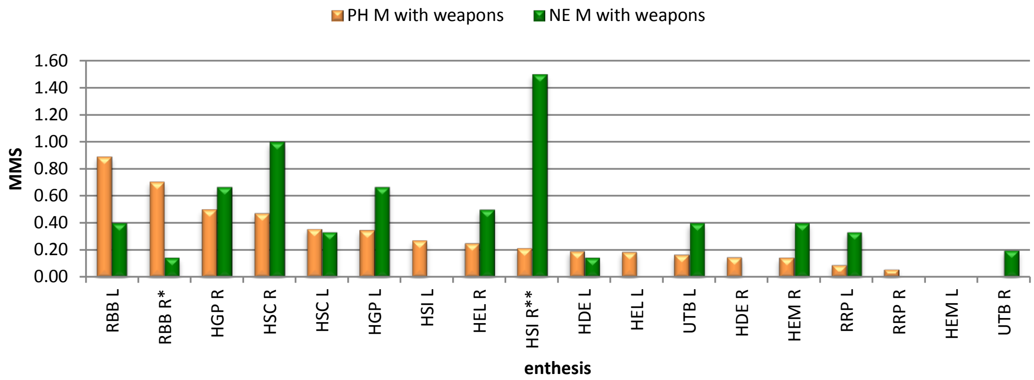


Fig. 7.94: Comparison of UL MMS of PH M W and NE M W, with PH M W as the leading group. Entheses showing a statistically significant difference in entheseal change are marked with */**.

Fig. 7.95 demonstrates that these muscles not only rank higher in M W at Neresheim, but also show a distinct pattern of more frequent entheseal change in this burial group compared to M W at Pleidelsheim. As can be seen in Fig. 7.94, males at Pleidelsheim do display changes to the majority of these entheses as well, however, with a less homogenous grouping of UL muscles than it is the case for males at Neresheim.

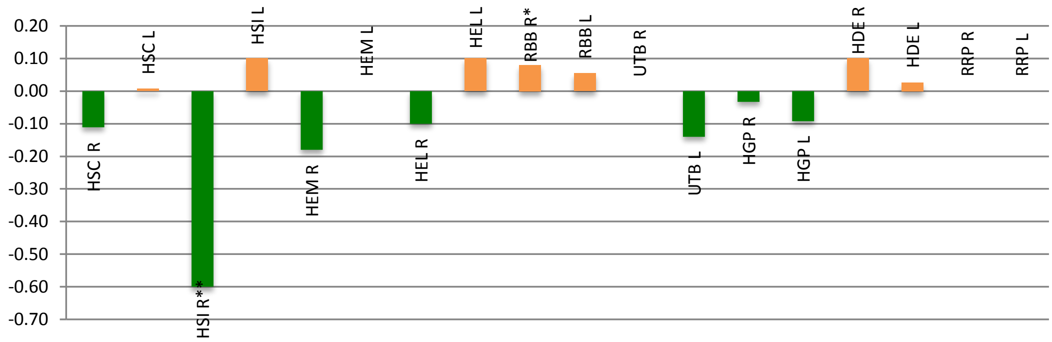


Fig. 7.95: Relative dimorphism of UL entheses between PH M W and NE M W (expressed as absolute differences between MMS for every enthesis, in all males; muscles with a positive value have higher rank ordering in PH M W)

b) Lower limb

Despite almost identical MMS for EC to the LL in M W at Pleidelsheim and Neresheim (cf. Table 7.37), males at Neresheim display significantly higher prevalences of osseous changes of the attachments of the left *Mm. triceps surae* (Achilles tendon) and *Mm. quadriceps femoris* than males at Pleidelsheim (Fig. 7.96; App. 7, Table 28). As Fig. 7.97 demonstrates, these entheses also represent those muscles that are more frequently affected in M W at Neresheim, while other differences in LL muscles remain negligible.

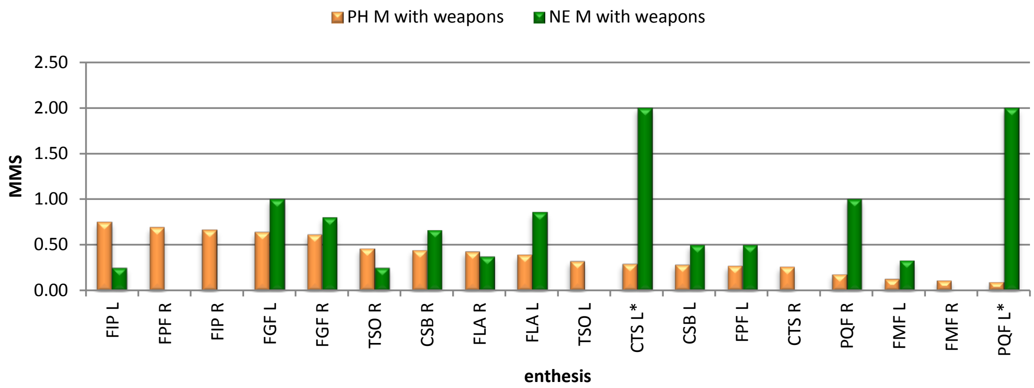


Fig. 7.96: Comparison of LL MMS of PH M W and NE M W, with PH M W as the leading group. Entheses showing a statistically significant difference in entheseal change are marked with *.

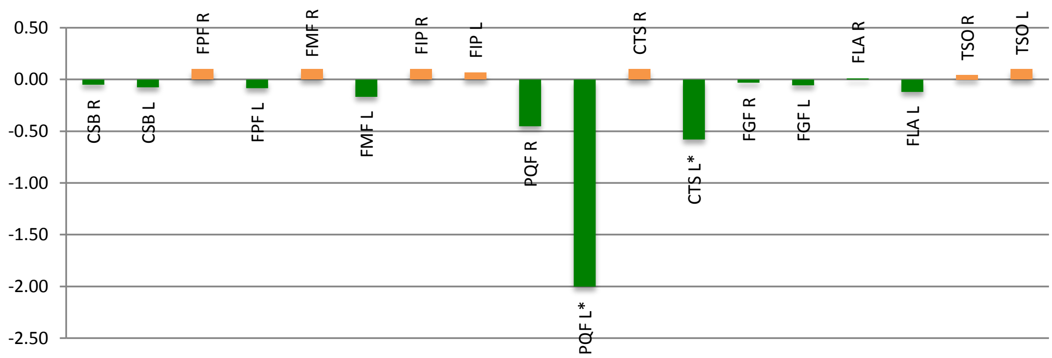


Fig. 7.97: Relative dimorphism of LL entheses between PH M W and NE M W (expressed as absolute differences between MMS for every enthesis, in all males; muscles with a positive value have higher rank ordering in PH M W)

7.3.3 Weapon burials - Active "warriors"?

The analysis of activity-related changes as indicated by osseous changes of muscular entheses in males interred in weapon burials at Pleidelsheim and Neresheim provides valuable information regarding the definition of weapon burial groups. Table 7.38 summarizes and compares the highest-ranking muscles in males buried with and without weapons in both cemeteries. It highlights the distinctive patterning found for entheseal changes in the group 'M W' at Neresheim and corroborates the evidence that emerged in the analysis of skeletal characteristics (cf. Chapter 6.3.3) - males buried with weapons at Neresheim present a distinctly defined group which is biologically distinguishable.

Table 7.38: Overview and comparison of highest-ranking muscles in males from Pleidelsheim and Neresheim, buried with and without weapons

<table>
<tr><th>PH M W</th><th>PH M N W</th><th>NE M W</th><th>NE M N W</th></tr>
<tr><td colspan="4">Upper Limb</td></tr>
<tr><td rowspan="6">M. biceps brachii (RBB) R + L</td><td>Mm. supra- & infraspinatus (HSI) L</td><td>Mm. supra- & infraspinatus (HSI) R</td><td rowspan="5">Mm. lateral epicondyle (HEL) L</td></tr>
<tr><td rowspan="4">Mm. lateral epicondyle (HEL) R + L</td><td>Mm. lateral epicondyle (HEL) R</td></tr>
<tr><td>Mm. medial epicondyle (HEM) R</td></tr>
<tr><td>M. pronator teres (RRP) L</td></tr>
<tr><td>M. triceps brachii (UTB) R</td></tr>
<tr><td>M. biceps brachii (RBB) R + L</td><td>M. biceps brachii (RBB) R</td><td>M. biceps brachii (RBB) R + L</td></tr>
<tr><td>M. pectoralis major (HGP) R + L</td><td>M. pectoralis major (HGP) R + L</td><td>M. pectoralis major (HGP) R + L</td><td>M. pectoralis major (HGP) R</td></tr>
<tr><td>M. subscapularis (HSC) R + L</td><td>M. subscapularis (HSC) R + L</td><td>M. subscapularis (HSC) R + L</td><td>M. subscapularis (HSC) R + L</td></tr>
<tr><td colspan="4">Lower Limb</td></tr>
<tr><td rowspan="2">M. iliopsoas (FIP) R + L</td><td>Mm. semimembranosus & biceps femoris (CSB) L</td><td>Mm. semimembranosus & biceps femoris (CSB) R + L</td><td>M. iliopsoas (FIP) L</td></tr>
<tr><td>Mm. quadriceps femoris (PQF) L</td><td>Mm. quadriceps femoris (PQF) R + L</td><td rowspan="2">M. gluteus medius (FMF) L</td></tr>
<tr><td>M. gluteus maximus (FGF) R + L</td><td>M. gluteus maximus (FGF) R + L</td><td>M. gluteus maximus (FGF) R + L</td></tr>
<tr><td rowspan="2">M. gluteus minimus (FPF) R</td><td rowspan="2">Achilles tendon (CTS) R + L</td><td>Achilles tendon (CTS) L</td><td>Achilles tendon (CTS) R</td></tr>
<tr><td>M. gluteus minimus (FPF) L</td><td>M. gluteus minimus (FPF) R</td></tr>
<tr><td>M. soleus (TSO) R</td><td>M. soleus (TSO) R</td><td>Mm. vastus medialis, adductor longus & brevis (FLA) L</td><td>M. soleus (TSO) R + L</td></tr>
</table>

At the same time, this comparison emphasizes the similarity of M W at Pleidelsheim with the rank-order patterns emerging for males in general, as well as the correspondences of UL patterns of EC for males buried without weapons in both populations. As the exploration of activity-related patterns for males in weapon burials proves highly intriguing, considering the variation noted within and between the burial groups at Pleidelsheim and Neresheim, Table 7.39 compares the findings from weapon burials in a more detailed survey, including a collation with results regarding entheseal changes in all males from both populations in order to reveal potential common functional muscle groups in both weapon burial populations that suggest a shared activity, and possibly one involving weapon use, that set them apart from the overall male population.

Males in weapon burials at Pleidelsheim possess an identical, even reduced range of high-ranking muscles in comparison to males in general, with no observable EC at young adulthood. Thus, those characteristics that set M W apart from other burial groups at Pleidelsheim are mainly entrenched in skeletal characteristics associated with physical stress other than MSM (cf. Chapter 6.3.3). Only a few entheses permit insight into differential muscle effects in M W, of which one (*M. triceps brachii*) only displays EC during old adulthood and another, *M. biceps brachii*, forming part of a group of very frequently affected muscles. This leaves the osseous changes of the enthesis of the common flexor muscles of the right hand and fingers as the only noteworthy development observed in males in weapon burials at Pleidelsheim, which may be connected with EC at the medial epicondyle, especially on the right humerus, indicative of weapon use (cf. Chapter 7.2.2.1).

Table 7.39: Comparison of entheseal changes as observed in males from all burials and weapon burials at Pleidelsheim and Neresheim

all PH M		***PH M W***		***all NE M***		***NE M W***	
UL	**LL**	**UL**	**LL**	**UL**	**LL**	**UL**	**LL**
Highest-ranking muscles							
RBB R + L HGP R + L HSC R + L HEL R	FGF R + L FPF R FIP R + L TSO R CTS L CSB L	RBB R + L HGP R + L HSC R + L	FGF R + L FPF R FIP R + L TSO R	RBB R + L HGP R + L HSC R + L HEL L	FGF R + L TSO R + L CTS R + L	RBB R HGP R + L HSC R + L HSI R HEL R HEM R RRP L	FGF R + L CTS L CSB R + L PQF R + L FPF L FLA L
Differential utilization (= greater stress found in M W)							
		HEM R RBB R + L **UTB L**	**FPF** R + L **FMF** R + L FIP R + L **FGF L**			HSC R HSI R **HEM R** HEL R **UTB** R + **L** HGP L	CSB R **FPF L** **FMF L** PQF R + L CTS L **FGF L** FLA L
EC occurring during young adulthood							
HSI R + L HEL R HGP R HDE R	FGF R + L FLA R + L TSO R + L	-	FGF R + L FLA R TSO R	HSC R **HSI R** HEL L **HGP** R + L HDE R	FPF R **FGF L** TSO R + L	**HSI R** HGP **L**	**FGF L**
EC occurring MAINLY during middle adulthood (_ = ONLY occurring during middle adulthood)							
[HGP R + L] **HDE L**	FMF R + L	HEL R **HDE** R + **L** RRP R		UTB R	[PQF L] CTS R + L TSO L	-	-
EC occurring ONLY during old adulthood							
UTB R + **L** HEM L	-	**UTB L**		HEL R	FMF L	(larger sample size needed)	(larger sample size needed)
Differential utilization (= greater stress found in PH M / PH M W)							
HSI L UTB R RRP R	**FPF R** **FMF R** **FIP R + L** FLA R	HSC L **HSI L** HEL L RBB R + L HDE R + L	**FPF R** **FMF R** **FIP R + L** CTS R TSO R + L				

For key to codes see Plate A (App.). Codes marked in **bold** = entheses occurring analogous among groups. Codes marked in yellow = distinctive to particular group.

At Neresheim, changes to the enthesis of the muscles of the medial epicondyle are of more relevance for males in weapon burials, as they occur among the most often affected muscles in the group 'M W', and a distinctive use can be attributed to this muscle group, yet no osseous changes to this enthesis could be detected at young adulthood, as opposed to those of right *Mm. supra- and infraspinatus* and left *M. pectoralis major* (Table 7.39). Considering EC in this burial group, in general, the reverse of the situation in the Pleidelsheim weapon burials is found: males in Neresheim weapon burials are very different from males in general, with a strong concentration of entheseal changes of the muscles of the right UL.

The present findings speak against the hypothesis of weapon burials as a common archaeological and anthropological entity in all Alamannic populations. The lack of similarity in entheseal changes in both groups with weapons (Table 7.39), the negative correlations with material evidence, i.e. weaponry, at Pleidelsheim (cf. Chapter 7.2.2.1), as well as the relational patterns uncovered for age, occurrence of EC as well as burial accoutrements in both populations indicates that a simplistic association between individuals buried with weapons and being “warriors” is not supported. While males at Neresheim provide some support for the existence of an active ‘warrior group’ than for males at Pleidelsheim, weaponry as grave goods appear to have been emblematic and / or a status symbol, with certain differences of meaning in burial customs occurring at different stages in the life course characteristic for males at Pleidelsheim and Neresheim.

7.4 Conclusion: Activity-related markers at Pleidelsheim and Neresheim

The variation between biological sex, age categories and burial groups among and between the populations of Pleidelsheim and Neresheim as suggested by the analysis of skeletal characteristics is complemented by the findings of the study of entheseal changes. The analysis allowed the observation and distinction of differential patterns of muscle effects and conclusively corroborates previous findings of this study, as it demonstrates that the individual’s age and sex, the burial environment, including burial accoutrement and grave type, and the combination of all these factors bear great significance for the understanding of status and identities in these two Alamannic societies.

On the population level, it was revealed that males display a greater number of EC than females at Pleidelsheim and at Neresheim, and individuals from Neresheim a greater number and variation of changes to muscular attachment sites than those from Pleidelsheim, albeit a greater degree of sexual dimorphism in the latter group, and a higher correlation between EC and age among Pleidelsheim males. It was demonstrated that muscle effects are linked to the age of the deceased as well as to potential muscle use that may have derived from a range of frequent, repetitive motions, not necessarily associated with the materials we find in the burials, although the combination of observed patterns into functional groups could point to certain specific activities common to individuals in the various groups. Younger adults form the only age category in which activity-related changes can be addressed without the peril of observing a combination of activity- and age-related changes or effects of the latter overall. In this category, males at both Pleidelsheim and Neresheim display distinctive patterns of entheseal alterations that suggest discrete activity-related patterns of muscle use for each population group. Younger females at Pleidelsheim show no signs of entheseal alterations, while females falling into in this age category at Neresheim display EC predominantly in the right UL. During middle adulthood, females at Pleidelsheim and Neresheim assume similar patterns of EC that are yet different to those of males, which may reflect a comparable ageing mechanism for females, but also common activities that differ from those of males as well as of younger females[110]. With old adulthood, ageing effects a similar pattern of entheseal changes in Pleidelsheim males and females as well as Neresheim females.

Overall, the differences revealed in this analysis appear to reflect local individuality and diversity in patterns of muscular changes that potentially indicate varying levels of physical stress and patterns of muscular activity that could be associated with the exercise of habitual tasks by males and females at Pleidelsheim and Neresheim. However, in general, the differences in entheseal effects with regard to activity-related changes discerned among burial groups are obscured by those linked to biological sex and age. While musculoskeletal stress markers in themselves may not necessarily provide evidence towards the use of items buried with the individuals, and are subject to various constraints with regard to biological influences on their development and expression, indications towards moderately defined activities for males and females at various stages in their lives are perceivable when considering activity-related changes as assessed by EC in combination with other skeletal characteristics (cf. Chapter 6.1).

With regard to burial types, no meaningful difference between individuals buried in 'simple' graves, coffins or grave chambers could be discerned with regard to varying activity patterns, with the exception of slightly divergent muscle effects observable in (young) males buried in grave chambers. The validity of the established 'burial groups' (cf. Chapter 6.2) is complemented, and significant differences were revealed especially with regard to the consideration of weapon burials. The fine differences observed with regard to skeletal health and susceptibility to disease and

[110] A potential combination of age- and activity-related changes is based on the absence of a corresponding observation in the male samples.

physical stress cannot be distinguished in the analysis of EC, as a differentiation of what causes alterations to muscular entheses cannot be made, especially with the onset of age-related changes to muscle attachments. Therefore, the general lack of significant differences in levels and patterns of EC between the groups of individuals buried with and those buried without GG and the detection of only slight differences is not surprising, considering the physical conditions presented by individuals from these burial groups (cf. Chapter 6.2). However, the finding of a greater number of EC in Neresheim males buried with GG than among those buried without any, as well as, at least in the UL, that of Pleidelsheim males and females buried without GG showing a higher number of entheseal alterations than individuals in the same group at Neresheim, provide interesting additional aspects to the definition of burial groups. In terms of activity-related changes, this analysis provided the information that at Pleidelsheim, males and females display no sign of entheseal changes and therefore indications of frequent or habitual muscular stress in the burial group 'M / F GG' during young adulthood, while those individuals buried without GG would exhibit an early onset of both minor and major EC.

A confirmation of burial groups was more strongly marked considering 'M W' and 'M NW', the analysis of entheseal alterations emphasizing the distinction of weapon-bearing males at Pleidelsheim and Neresheim. Similar to the findings made with regard to skeletal health (cf. Chapter 6.3.3), at Pleidelsheim, no meaningful difference was discernible regarding patterns of EC between males buried with weapons and males buried with GG in general. At Neresheim, however, activity-related changes as signified by EC observable in younger adult males complete the weapon burial group to a more strongly biologically defined one than it is the case for males at Pleidelsheim.

Hence, overall, the results regarding activity-related markers greatly enhance the insight into the varying patterns biological and archaeological data provide about the lifestyles and social identities of the Alamanni at Pleidelsheim and Neresheim.

"There is very little difference between one man and another; but what little there is, - is very important -.' This distinction seems to me to go to the root of the matter."
William James, *The Importance of Individuals*

8 Discussion

8.1 Sex, gender, age, and the funerary treatment: Testimony of Alamannic life

8.1.1 What makes an Alaman?

The results of this study have shown that '*the Alamanni*' present very different facets of social identity, in the case of Pleidelsheim and Neresheim, two local societies, both in life and death. The existence of a general pattern versus local variability with regard to funerary rites has been noted by other scholars in early medieval contexts (e.g. Pader 1982 ; Effros 2003: 128; Halsall 2010a: 326), however, the differences traced in these two Alamannic populations reach beyond variability in the funerary rite. They encompass social identities and complexities, the social and physical bodies of the people in Pleidelsheim and Neresheim. They speak for a diversity within the period and its people that defies any axiomatic categorisation into men and women, rich and poor, and a generalisation of *'the Alamanni'*.

It starts with the objects we find in their graves: they may seem the same, and yet they are not. Not only are noticeable differences present with regard to the "wealth" of both cemeteries - Pleidelsheim with generally wealthy assemblages of material culture and a variety of artefact types, Neresheim with a more confined number and choice of objects - which was most certainly related to their geographical and economic settings; the significance of certain artefacts as well as the composition of artefact assemblages differs to an important degree between the two sites, with essential implications for the characterisation of its populations.

In Pleidelsheim, males are characterized by weaponry (sword, shield, axe, as well as seax, arrows and lance), horse riding equipment, and items pertaining to feasting and personal equipment. If not buried with weaponry, the presence of bronze vessels, tools and flint as well as potentially a more elaborate belt buckle may indicate a male assemblage, but those males buried without weapons are not really engendered by any other items than these. Females are characterized by items associated with dress and jewellery, by all means a common gendering element for early medieval females (e.g. Stoodley 1999 ; Härke *et al.* 2000), as well as with household and textile work-related implements (although both objects, spindle whorl and weaving sword, could be also considered as symbolic[111] for the supervisory role of such tasks (Härke *et al.* 2000: 194)). If their burials do not contain any of these items, the presence of beads or amulets may still indicate a female individual in the grave. However, many items belonging to the spheres of drinking and feasting, toiletry and maintenance (combs, scissors, tweezers) and the household are neutral (i.e. neither associated exclusively with males or females) in Pleidelsheim burial contexts.

In Neresheim, males are also characterised by weaponry (sword, lance, and shield) and horse riding equipment but, additionally, by the presence of tools and toiletry items. In this cemetery population, males buried without weaponry cannot be

[111] Considering a high degree of symbolism, reference must also be made to the female figure of the "peace-weaver" (Enright 1990), "one who weaves communal ties or peace-creating bonds within society" (Hyer 2005: 36). In Old English literature (for instance, in *Beowulf*), but also in Germanic tradition, a peace-weaver is defined socio-politically as a noble woman (i.e. an aristocratic woman, even a queen) who brings "peace between two tribes through marriage and children" (Jamison 2004: 3), thus her child-bearing capacity is seen as a potential bringer of peace, as it aids the forming of alliances between families or tribes, a thought encountered before with regard to Alamannic gender identity (cf. Chapter 3). Moreover, the concept of loyalty is strongly intertwined with peace weaving and the role of the woman (Jamison 2004: 30ff.).

engendered by an “alternative” set of grave goods, other than maybe tools. Females in Neresheim, overall receiving even fewer artefacts than males, display items associated with textile work as well as dress and costume, similar to females in Pleidelsheim, however, marked by fewer artefact types; yet the presence of coins, a ‘neutral’ burial artefact in Pleidelsheim, seems to indicate a female burial in Neresheim. Apart from items of personal equipment that seem to be universally ‘neutral’ in Alamannic populations (e.g. knives, belts and belt sets), as well as items associated with drinking and feasting, the ‘weaponry’ types seax and arrows are flexibly neutral in the Neresheim cemetery context.

It seems that those individuals buried with greater number of grave inclusions, i.e. the population of Pleidelsheim, also permit more visible gendered categories. Considering the change in grave good customs, engendering is even increased in Pleidelsheim in the course of the 6th century and at the beginning of the 7th century, when items of grave furnishings within male burials start to plummet in numbers, while remaining sustained in female burials. Furthermore, in Pleidelsheim, males buried without weapons are still potentially gendered by the inclusion of other objects, although their burial wealth is very much linked to the inclusion of weaponry; on the contrary, in Neresheim, weaponry is an essential element for engendering males, artefactually masculine graves without weapons do not seem to exist. This is reinforced by the fact that despite a general decrease in the presence of material objects in Neresheim at the beginning of the 6th century, the appearance of weaponry in male burials in Neresheim remains unceasing before it increases with the 7th century, as opposed to circumstances in Pleidelsheim, where weaponry sees the same decrease as a burial accoutrement as all other material items with the course of the 7th century.

Considering females, they are strongly engendered in Pleidelsheim and Neresheim, albeit with slightly differing objects and an emphasis in the "wealthier" population on items of dress and jewellery. In Neresheim, however, items belonging to dress and costume are relatively sustained throughout the 6th century, when other items of female grave furnishing see a drop in numbers before increasing again with the 7th century. Overall, it seems that in Pleidelsheim, the whole burial rite is more highly engendered, given that females were often buried with a quantity of grave goods that equals that of males and, moreover, occur more frequently in grave chambers. Males in Pleidelsheim were significantly more frequently buried in coffins than were females, but also very wealthily endowed with material goods, indicating a "compensation" of energy consumption[112] afforded for the burial display by enhanced artefact deposition. Pleidelsheim females were increasingly buried in grave chambers in the course of time and, in most cases, with a relatively wealthy grave good assemblage, while in Neresheim, the burial of a female in a grave chamber seems to present the expenditure itself, as grave furnishing is comparatively low in these cases (for instance, a female who died aged between 36 - 45 years, was found in an intact grave chamber without any objects). In a society where the availability of objects (either in general or expendable for the burial rite and display) was restricted, emphasizing gender by grave good associations appears not to have been very important, the burial accoutrements rather marked by items of weaponry and jewellery which were affiliated with its male or female 'owner' for

[112] i.e. expenditure (Tainter 1978)

a variety of reasons (the simplest one being the characterisation of certain age groups in this society by the visible artefacts of dress, jewellery or weaponry). As opposed to Pleidelsheim, where also the female grave good assemblages altogether decrease in the course of the 7th century, the endowment of female burials with gendered as well as 'neutral' items increases with the 7th century, concurrent with the masculine grave good assemblage changes, strengthening the feminine burial assemblage at a time when its significance appears to dwindle in another Alamannic population.

Not only can we recognise evidence for changes in the material construction of gender in the course of time at both cemeteries, but much more profound indications of the differing social make-up of Pleidelsheim and Neresheim. Circumstances of grave good deposition and their characterisation with regard to male and female gender in Pleidelsheim supports a suggestion made by Härke (Härke *et al.* 2000 ; 2011) (see Chapter 3.2.2): following the idea of potentially increased social instability in the wake of migrations that may have affected the social fabric, Härke points out that the lack of clear traditional boundaries and differences with regard to gender roles and age-related status (i.e. in an *open ranked society* as proposed by Steuer) that may have resulted from high individual and group mobility could lead to a heightened insecurity about one's own identity and the social norms of a group (Härke *et al.* 2000: 195). Thus, gender may be emphasized in the ritual display of death where this boundary was lost in life, the more so by societies that were marked more strongly by this phenomenon. All evidence points to the Pleidelsheim society having placed such a ritual emphasis on these boundaries - presenting the society as it “should be”, with more defined traditional gender roles, not as it is (Härke 2011), thus an identity in death, not necessarily a lived identity - engendering as a “symptom” of a society with low levels of social stratification. Local society at Pleidelsheim may have strongly represented what Steuer believed to be an open ranked society with fluid boundaries characterized by achievement - male or female. The absence of a defined social hierarchy appears to have led to the increased accentuation of gender identity in the burial rite.

In contrast to this, we find the Alamannic society of Neresheim: there must have been a reason why gender display in the burial appears to have been less important, or possibly not important at all. Other identities may have assumed its place. Not only does the weaponry deposition in male burials as the only engendering artefact group decisively point to this, strongly interrelated with facets of age and entitlement, as will be discussed very shortly, but also the patterns of decrease and increase in grave good deposition in Pleidelsheim and Neresheim. If Pleidelsheim individuals emphasised gender noticeably in their burials and with this bequeathed the information to us that indeed, social stratification in life was hardly marked by this notion of being male or female as a societal boundary, then the heightened emphasis on female gender through grave goods just before the general decline of the grave good custom indicate what Steuer (2004) has suggested for societal change and a re-structuring of societies with the time around 700 AD in Merovingian societies in general. Formerly open ranked societies, describing rank via the burial display and potentially using the burial rite in their competition to express their status[113], show an increase in social stratification in the course of the 8th century and the change to an extenuated display of status in their burials, as this is now, in a more strictly structured and less unstable society, not necessary any longer. Rank and status are determined by other mechanisms that are much more constricted and described within a societal system that relies on dependencies and rights - such as found in the Frankish kingdom, so often consulted for outlining the Alamannic society of Pleidelsheim, an endeavour that was quite inappropriately applied, as is now strikingly noticeable.

While in Pleidelsheim the grave good deposition declines for both males and females, an observation that concurs with phenomena in early Anglo-Saxon cemeteries, for example (Härke 1989), Merovingian (and Alamannic) row grave cemeteries are increasingly marked by the appearance of separate burial grounds (e.g. Kirchheim a. R., Neuffer-Müller 1983) and the representation of status by new means, such as tumulus graves (Christlein 1991: 91). A new élite is emerging with the 8th century, and formerly open ranked societies with fluid boundaries, high mobility between ranks and status principally based on social permeability transform into hierarchised societies once more. Although we do not have evidence of such a cemetery transformation in itself in Pleidelsheim, the burial customs provide evidence for such an open ranked societal structure to have indeed existed for this local Alamannic population between the 5th and 7th century - whether this could have included all the vertically hierarchising status distinctions proposed by

[113] Härke *et al.* (2000: 194) mention that such mechanism marks 'chiefdom societies' which were wedged in between periods of more hierarchised societies. As Steuer (2004) points out, chiefdom societies, though being ranked societies, are ethnographically based on the heritability of the leader's position, associated with the membership in the oldest or mightiest family in the local society. It cannot be answered at this point for Pleidelsheim whether any such structures were present or not, however, the description of Pleidelsheim as a 'chiefdom society' may be possible, forming one of many such societies that shaped the Merovingian kingdom (cf. Steuer 2004).

Steuer (see Chapter 2.3.2), however, is unlikely, as further discussion will show. This proposition is supported by the ‘weapon burial’ evidence: although the (discretionary) combination of sword, shield, axe, lance, as well as possible arrows and seax, if one wanted to include those artefacts as ‘weaponry’, appears to describe the adult male in Pleidelsheim, these items are not confined to adulthood, and do not cease to appear as grave good with old age, as will be manifest in the life course description of a Pleidelsheim male. Hence, an *active* military service expressed by the weapon endowment can be obviated, its symbolism is substantiated and, with this, this accoutrement is comparable to other early medieval cemeteries with similar evidence for little hierarchized social structures where “weapon burials” denote facets other than straightforwardly male sex (e.g. Härke 1992). Moreover, the occurrence of weaponry in Pleidelsheim does not conform to a ‘Frankish’ or, entirely, an ‘Alamannic’ *culture model* (Siegmund 1997 ; Brather 2002), the latter probably considering the fact that indeed not all Alamanni were and acted the same, while the rapprochement to Frankish customs and societal echelon would only set in with the 7th century, as is discernible with the decline in weaponry as grave inclusions.

Neresheim shows a quite contrary picture to Pleidelsheim. Gender expressed in material culture included in the burial is confined to fewer items for males and females, the burial ritual does not seem to have been used for emphasising general gender related boundaries. It might be that the polarity between male and female was much more pronounced in life, reflected in the differential treatment with regard to burial accoutrement for males and females; females received less burial wealth than males, as opposed to the Alamanni in Pleidelsheim, where males and females were treated comparably and overall equally in death with regard to quantity and variety of grave goods, and age-related patterns in the burial custom support a very different context of life and status for females in both societies.

Before we turn to the question of age as a pivotal concept influencing the burial rite, patterns of grave good deposition in Neresheim comply with previously suspected occurrences marking this Alamannic society. Knaut (1993: 191) sees a decline in burial intensity with the second generation of the 6th century in Neresheim, which he ascribes to the integration of tribes into the Frankish empire at around that time. Not only does this serve as an explanation for the decline in material culture as retrieved from the burial context, but it also shows that the Alamanni in Neresheim showed an entirely different response to the political events of the time than is observable in Pleidelsheim. The latter society follows a pattern that has been already described for a variety of Alamannic cemeteries whose societies were incorporated into the Frankish realm and located in geographical areas that were either relatively close to the centre of power or of strategic importance with regard to trade and economy. The people of Neresheim, at the far border of the Frankish empire located in a less hospitable environment (see Chapter 4.1), display traits of a society that was not only more polarised in terms of various groups within its population, but also more marginalised and marked by a more defensive character, considering the emphasis placed onto certain types of artefacts such as weaponry and their categorical association with males. The assessment of “weapon burials” underpins this interpretation also in this case. At Neresheim, weapons, while consistently present in the burial rite, see a steady increase with the course of the

6th to 7th century; moreover, weaponry is strictly confined to young middle to mature adulthood (i.e. *c.* 26 - 59 years), with the exception of arrows that appear to cease as grave inclusion with young adulthood, accentuating a much stronger "active" character of Alamannic males buried with weaponry at this cemetery.

8.1.2 The Alamannic life course

The differences uncovered in the tracing and consideration of the life course for males and females in Pleidelsheim and Neresheim not only underpin the differences between the two Alamannic populations, but also reveal vital information about the life cycles and social significance of men and women as expressed in the burial rite, interlaced with a better understanding of the meaning of certain grave good assemblages. A look at the differential deposition of grave goods and artefact-types (following a suggestion by Halsall (1998b), who applied a similar collocation with regard to early medieval burials in Lorraine) reveals the interrelations of gender and age identity that form a considerable part of understanding the Alamanni in those two local societies. The compilation of results from the study of burial assemblages, grave types, and biological age and sex permit description of the life course for an Alamannic boy and girl in the settlements of Pleidelsheim and Neresheim, as well as an insight into the very different social fabric of both populations.

a) Pleidelsheim

Age grades in the life course of a boy

For a boy growing up in Pleidelsheim, life would have consisted of a series of liminal stages and thresholds, as can be identified from the burial rite (Table 8.1). If being so unfortunate as to perish in (early) childhood, he would have been given a burial rite that could include interment in any of the three main grave types, as well as in most cases, the accoutrement of neutral and gender-associated objects (cf. Table 8.2). Whether this constitutes a “premature correlation to later roles” (Brather 2009: 40) remains to be seen, however, the child as an “extension of the mother”, as hypothesised by Halsall (2010a: 345) with regard to mainly neutral or feminine artefacts in early medieval burials, can be set aside with regard to this population. While not much change in the burial rite can be seen should a boy have grown older, apart from bestowing him with a greater artefactual variety, there is some associated with adolescence: the engendering axe appears as a burial artefact[114], associated with the recurring appearance of a seax, while overall burial wealth remains constant, instead of declining.

[114] Thus, the axe does not only occur in adult male graves and, as such, is a weapon or, then, a symbol of a mature man’s rank (Brather 2009). Theuws (2009) questions the axe as a true weapon-type, arguing that if it had denoted a warrior, why choose an axe of all weapons? It may have rather been a “military (and agricultural) idiom” (Theuws 2009: 302), which would, importantly, not weaken an association with masculinity.

Table 8.1: Grave good deposition customs in Pleidelsheim

Age	Male	Female
early childhood (*c.* 1 - 6 years)	Small children are buried with mostly neutral [a)] AT, few with gender-associated AT (necklace for feminine burials, seax, tool items and flint for masculine burials); girls receive a higher variety and quantity of objects than boys. The greater proportion of boys and girls are buried in furnished graves.	
late childhood (*c.* 7 - 12 years)	In later childhood, both (boys and girls) receive greater artefactual wealth, still artefactually neutral. The elaborate belt buckle is the only gender-associated object found in male burials. A greater proportion of graves remains unfurnished.	Girls receive significantly greater quantities than boys. All burials are furnished. The spindle whorl occurs as an engendering object.
adolescence (*c.* 13 - 17 years)	The artefactual wealth remains constant, fewer graves are left unfurnished. We see the appearance of the engendering axe, as well as the gender-associated seax.	The average quantity and variety of GG drops below that of adolescent men and remains completely neutral. However, all burials are furnished.
young adulthood (*c.* 18 - 25 years)	Burial wealth increases, all burials are furnished. Gendered as well as elaborate objects appear (weaponry: sword and lance, in addition to seax and arrows).	Burial wealth increases considerably, all burials are furnished. Gendered as well as elaborate objects appear (wooden casket, spindle whorl, fibulae).
young middle adulthood (*c.* 26 - 35 years)	Men receive the full complement of gendered and elaborate objects (weaponry: sword, shield, lance, axe, in addition to seax and arrows), and higher quantities than during young adulthood. A relatively small proportion of burials remain unfurnished.	Women receive the full complement of gendered and elaborate objects (dress and jewellery components), and higher quantities than during young adulthood. A relatively small proportion of burials remain unfurnished.
old middle adulthood (*c.* 36 - 45 years)	The character of the grave good assemblages remains the same as during young middle adulthood, with even higher quantities of GG than earlier. A relatively small proportion of burials remain unfurnished.	The character of the grave good assemblages remains the same as during young adulthood, some engendered items only appear at this stage (e.g. weaving sword). All burials are furnished, and women receive the highest quantity and variety of artefacts overall (more than men).
mature adulthood (*c.* 46 - 59 years)	The character of the grave good assemblages remains the same as before. Men receive the highest quantity and variety of artefacts overall. However, a greater proportion of men is buried without GG (and therefore ungendered) than in any other age category.	The character of the grave good assemblages remains the same as before, with slightly lower quantities of GG than during old middle adulthood. A greater proportion of women is buried without GG (and therefore ungendered) than in any other age category.
old adulthood (60+ years)	Men appear to receive fewer items of weaponry, as well as slightly less variety and wealth of AT, but not noticeably. Gendered and elaborate objects still occur (lance, axe, in addition to seax and arrows), but the proportion of neutral artefacts increases. More men than women are buried in unfurnished graves.	Women are buried with lesser quantities than during mature adulthood, yet the character of the grave good assemblages remains the same, including gendered and elaborate objects.

[a] The term 'neutral' is used to designate artefact-types found commonly in male and female burials, according to the criteria established in Chapter 5.2.1. Differences in the object distribution in detail can be found in Table 8.2.

Key: GG = grave good, AT = artefact-type; yellow cells = liminal stage, light blue cells = age threshold, light orange cells = peak of burial endowment.

It appears that, with adolescence, we see the onset of a transitional period in Pleidelsheim boyhood, coinciding with puberty. It might be the first step in a process of male "socialization" (Halsall 1998b; 2010a: 345) in society, which continues during young adulthood, a time when no young man is buried without grave goods and may be the recipient of sword and / or lance, in addition to engendering and sometimes comparatively elaborate artefacts (Table 8.1; Table 8.2), an indication for the death of such a young person having caused great tension in his group and society. This process culminates with young middle adulthood, i.e. in the mid-twenties to early thirties of a young man's life. Although a small number of burials remain unfurnished in this age category, men receive a full complement of weaponry, creating a relatively wealthy assemblage, as the value of such weaponry equipment (often described as that of a "fully armed warrior" (Frassetto 2003: 365) and a powerful man) is assumed to be relatively high (Frassetto 2003: 365; Halsall 2003b: 164). This stage marks full adulthood for men in Pleidelsheim, but it also suggests something else - in Pleidelsheim, the appearance of differing items of weaponry in the life course from adolescence to young middle adulthood may be associated with the ritualized "becoming of a (noble, in actuality or figuratively) man" (see Chapter 3.2.3). Of course the bestowing of a sword at young adulthood may point to the ability to use it, and a very wealthy burial assemblage bespeak the man's role as head of the *familia* (Brather 2009) or the lamented potential to become one, but comprehensively, the death of a man of this age seemed to have caused much grief in the Pleidelsheim society; his social role must have been significant for the people around him. This extends into old middle adulthood and finds its greatest expression in the burial rite during mature adulthood (Table 8.1) - the graves are still equipped very wealthily and mostly furnished, thus the male social role, whether as a man, father, head of the household or possibly military retainer (considering the still incessant appearance of weapon sets) may not have changed during these life stages. That the greatest proportion of unfurnished graves are found in the age category of mature adulthood may stem from the fact that the mortality rates reach their peak for males in this population during that age, and not all were afforded a high expenditure; it may be, on the other hand, an indicator for different male social groups that emerge from the burial record at this stage. Halsall (2010b: 370) suggests another possibility, namely that those men buried with grave goods would have still held their role as important member of the *familia*, their burial display thus demonstrating the easing of social tension, while those men buried without any grave goods (and therefore ungendered) would have assumed a different social space in society already, with their sons having taken over leadership or similar roles. What speaks against this separation founded in social importance, however, is that material "ungendering" and a loss of social significance as a man and the gender role of "head" or "leader" that could be associated with it never genuinely happens in this society. There might be a decrease in the wealth of the artefact assemblage by the end of a man's 50s, but not synonymously with a diminishing of social importance and masculinity. Even in old age, artefacts still mark a man, albeit a great proportion are buried in unfurnished graves also in this age category (Table 8.1). It is interesting, however, that bestowing a lance[115], as observed at old age[116] (Table 8.2), accentuates the symbolic meaning of weaponry in this society; throughout Merovingian and Carolingian times, a lance constituted an important symbol (cf. for instance Greg. Tur. *Hist.* V.17; Gasparri 2000: 99ff.), but it is assumed to have been the least highly prized item of weaponry (Frassetto 2003: 366).

[115] The consistent appearance of a lance as grave accoutrement through to old age has been observed in a few other Alamannic cemeteries, e.g. Eichstetten (Sasse 2001), while in others, its occurrence seems to cease with mature adulthood (Brather 2009).

[116] Interestingly, the deposition of lance and axe, as observed at old age in Pleidelsheim, marks 4th century "weapon burials" and the beginning of the weapon burial rite (Theuws 2009: 297). In older literature, they were automatically classified as 'functional weapons' (Böhme 1974), however, their deposition with regard to age in this cemetery speaks against this.

Age grades in the life course of a girl

When an infant girl died in Pleidelsheim - given the higher risk of mortality for girls than for boys during early childhood, probably a relatively frequent and mournful event - she was likely to be buried with a greater wealth and variety of neutral and gender-associated artefacts than a boy of the same age (Table 8.1), however, most likely in a simple grave - the material display of wealth may have been considered more impactful in the demonstration of loss than the type of grave. In this aspect, it could indeed be the case that the later redactions of the *Leges Alamannorum* (cf. Chapter 3) reflect the circumstances encountered in the Alamannic burial rite in settlements such as Pleidelsheim. Whether or not the Salian Laws with their disproportionally high *wergild* for girls in early childhood actually refer to a punishment for practicing infanticide (cf. Lohrke 1999 ; 2004a: 35ff., 174; Brather 2004b ; 2009) cannot be answered here[117]. In the Alamannic context, the association of the relatively well-accompanied burial with the articulation of the great loss the death of a girl meant to a family, considering her "potential" in the future as a family member to be married off, hence forging alliances and securing the family's status (Brather 2008b), is a much more relevant thought with regard to female status. However, this argument based on the law codes and *wergild* does not bear up, considering they only declare a high "value" for infant girls; what would support the argument to a much more meaningful extent is that, rather than the number of grave goods, it appears to be the fact that from late childhood up into young adulthood, no woman was buried in an unfurnished grave (Table 8.1).

[117] According to the Frankish laws (Weidemann 1982: 313ff.), both forms of marriage payment, dowry and bride price existed, and thus a reasoning for or against infanticide on the grounds of law codes and marriage duties does not aid a resolution of the problem.

Indeed, however, as opposed to boys and adolescent men in Pleidelsheim, the *wealth* of the burial assemblage drops in female graves, indicating a liminal stage for young adult women in this society (Table 8.1), displaying the onset of the material construction of gender at this stage (Table 8.2). This leads up to an age threshold for women which coincides with that of men, as women receive a full complement of gendered and elaborate objects should they pass away during young middle adulthood (Table 8.1), as well as the frequent burial in grave chambers. A woman's death throughout middle adulthood, especially during later stages, which coincides with the highest mortality rates for females in Pleidelsheim, is paid tribute to with the wealthiest grave good assemblages, which are higher than that of men at the same stage and occur throughout the female burials (Table 8.1). Thus, a woman's social importance in Pleidelsheim does not appear to be solely related to her biological abilities, her social role not inseparable from her biological role (e.g. Brather 2009), but rather to her function within a *familia* and greater social group. A change of this social significance can be observed somewhat earlier than in men; when passing away during mature adulthood, women retain items related to household, dress and jewellery (Table 8.3), not less than before, but in slightly different compositions. This remains the case up into old age (Table 8.1), with bodily adornment clearly conveying female status[118], and the women, just like the men, but surviving more frequently into old age, never lose their gendered identity. Interestingly, the proportion of unfurnished and hence ungendered burials is also greatest during mature adulthood for women (Table 8.1), which might highlight a transpiring differentiation of male and female status in this population.

[118] Objects such as fibulae were not confined to women from young to mature adulthood, but certain items may have displayed an age-related emphasis through their higher quality, e.g. silver/gold versus bronze pins or fibulae (Stauch 2008).

In Pleidelsheim, gender identity is patently emphasised in the burial ritual, starting with the engendering of children, whereas with regard to age, males and females show an overall equal treatment in death and similar socio-cultural thresholds in life.

Pleidelsheim	
masculine thresholds:	I) i) puberty ii) 18 - 25 years iii) *26 - 35 years*
	II) *mature adulthood (around 50 years)*
feminine thresholds:	I) i) 18-25 years ii) *26 - 35 years*
	II) *around 40 - 50 years*

On the whole, women seem to receive a slightly better burial display, considering that for instance the introduction of “new” grave types (i.e. grave chambers) is used more often for female burial in Pleidelsheim. Yet, biological sex and its gendered material construction in death are not the basis for status in life in Pleidelsheim. Gender roles such as the woman as mother and wife, i.e. female definition by reproductive abilities, and the man only apparently important during the “prime of his years” and in his social rank and function defined by the proximity to a king (e.g. Brather 2008b; 2009), appear to be subordinate to social status. The concept of less wealth in burials of younger and elderly individuals imparting a lower to no social importance (Brather 2008b) does not seem to follow. It rather seems that greater and more significant divisions with regard to status in life within the gender groups unfold between the lines of the life course as expressed in death. The relatively equal sex ratio of groups consisting of unfurnished burials in every age category indicates that status was very much influenced by factors intertwined with kinship and, potentially, inheritance.

Perhaps the Alamannic *Leges*, to the chagrin of scholars, revolve primarily around gender and social rank (see Chapter 3.2.3) - but if they really were based on already existing societal structures (a "law emerging from the society to which it applies" (Wormald 2003: 22)), then Pleidelsheim sets a prime example for the situation preceding the law codes and reflecting their later emphases.

Table 8.2: Summary overview of individual artefact-types and their occurrence according to gender and age as found in male and female burials in Pleidelsheim and Neresheim

Pleidelsheim		Neresheim	
exclusively M			
sword	YA - MTA (*c.* 18 - 59 years)	**sword**	YMA - MTA (*c.* 26 - 59 years)
shield	YMA - MTA (*c.* 26 - 59 years)	**lance**	YMA; MTA (*c.* 26 - 59 years)
axe	all ages	**snaffle & harness**	YMA (*c.* 26 - 35 years)
spur	YMA - OMA (*c.* 26 - 45 years)	**spur**	YMA (*c.* 26 - 35 years)
(sewing) needle	YMA - MTA (*c.* 26 - 59 years)	**eggshells**	ECH; YA (*c.* 1 - 25 years)
bronze ware	OMA (*c.* 36 - 45 years)	**tools**	YMA - MTA (*c.* 26 - 59 years)
		(keys)	ECH (*c.* 1 - 6 years)
		tweezers	OA (60+ years)
		bracelet	OMA (*c.* 36 - 45 years)
strongly M			
seax	all ages (M), YMA (F)	**shield**	YMA; MTA (*c.* 26 - 59 years)
arrows	all ages (M, F)		
lance	YA - OA (*c.* 18 - 60+ years)	**flint**	YA - MTA (*c.* 18 - 49 years)
elaborate belt buckle	LCH - OA (all ages, M, F)		
tools	all ages		
flint	ECH - MTA (*c.* 1 - 59 years)		
exclusively F			
wooden casket	YA - OA (*c.* 18 - 60+ years)	**coins**	YMA (*c.* 26 - 35 years)
spindle whorl	LCH - OA (all ages)	**(sewing) needle**	LCH (*c.* 7 - 12 years)
weaving sword	OMA (*c.* 36 - 45 years)	**weaving sword**	AD - YMA, MTA (*c.* 13 - 59 years)
		bucket sleeve and set	YA, OMA (*c.* 18 - 45 years)
bronze beads	OMA (*c.* 36 - 45 years)		
necklace	all ages	**ring**	YMA - OMA (*c.* 26 - 45 years)
earrings	YMA - MTA (*c.* 26 - 59 years)	**amulet**	OMA (*c.* 36 - 45 years)
fibulae (all)	YA - OA (*c.* 18 - 59 years)	**calf decoration**	YA - MTA (*c.* 18 - 59 years)
strongly F			
amulet	ECH; YA - MTA (*poss.* all ages)	**earrings**	YA - OMA (*c.* 18 - 45 years)
beads	all ages	**fibulae (all)**	YA - MTA (*c.* 18 - 59 years)
glass beads	all ages		
(hair-)pin	YMA - OA (*c.* 26 - 60+ years)		
neutral			
wooden bucket	OMA (M), [OMA (F)]	**seax**	YA - OA (M), AD, MTA (F)
glassware	AD - MTA (M), all ages (F)	**arrows**	ECH - YA (M), LCH, YMA, MTA (F)
bucket w. fittings	OMA (M), YMA (F)		
pottery	all ages (M, F)	**glassware**	LCH, MTA (M), LCH, YA (F)
eggshells	YMA - MTA (M, F)	**pottery**	all ages (M), YA - MTA (F)
ring	YMA (M), ECH - MTA (F)		
coins	YMA - MTA (M), ECH, MA (F)	**elaborate belt buckle**	all ages (M), AD, YMA (F)
simple belt buckle	all ages (M, F)	**simple belt buckle**	all ages (M), LCH - OA (F)
belt set	all ages (M, F)	**belt set**	all ages (M), LCH - MTA (F)
comb	all ages (M, F)	**knife**	LCH - OA (M), LCH, YA - OA (F)
knife	all ages (M, F)		
scissors	YA - OA (M), YMA - MTA (F)	**beads**	ECH, OMA (M), AD - MTA (F)
tweezers	YMA - MTA (M), YA - MTA (F)	**glass beads**	C, OMA (M), ECH - MTA (F)
keys	ECH, YA, MTA (M), YA - MTA (F)	**bronze beads**	[ECH (M), OMA (F)]
bracelet	[YA (M, F)]	**(hair-)pin**	[ECH (M)], YA, YMA (F)
calf decoration	[YA (M), OMA (F)]		

Key: ECH = early childhood, LCH = late childhood, AD = adolescence, YA = young adulthood, YMA = young middle adulthood, OMA = old middle adulthood, MTA = mature adulthood, OA = old adulthood, MA = middle adulthood, C = childhood; M = males, F = females, [] = sample size not representative

b) Neresheim

The society of Neresheim, located on the fringes of Alamannia and the Frankish empire, seems to have been following very different principles in life and death.

Table 8.3: Grave good deposition customs in Neresheim

Age	Male	Female
early childhood (*c.* 1 - 6 years)	Small children are buried with neutral [a)] AT. Boys receive a considerably higher quantity and variety of AT than girls, including arrows, and the greater proportion of them is buried in furnished graves, while the greater proportion of female burials contains no artefacts, to a greater extent than male burials in the same age category.	
late childhood (*c.* 7 - 12 years)	Boys receive lower quantities and varieties of GG than during early childhood, the assemblage remaining neutral and including arrows. The proportion of boys buried with and without GG is comparable.	Girls now receive a much higher variety of AT than during early childhood, and significantly more and varying objects than boys, although of largely neutral character, the only engendering artefact being a (sewing) needle.
adolescence (*c.* 13 - 17 years)	While the character and variety of the GG assemblage remains the same as during late childhood, the average wealth decreases.	The average quantity and variety of GG drops below that of adolescent men, however, all burials appear to be furnished. The neutral GG assemblage is complemented by the engendering addition of a weaving sword.
young adulthood (*c.* 18 - 25 years)	The average quantity and variety of GG drops below that of an adolescent, with all GG being neutral in character. This is the last stage in which arrows appear as accoutrement. It is possible, however, that all burials are furnished in this age category.	Women receive the full complement of gendered and elaborate objects (dress and jewellery components), and considerably higher quantities and varieties than during young adulthood. All burials are furnished.
young middle adulthood (*c.* 26 - 35 years)	Men receive the full complement of gendered and elaborate objects (weaponry: sword, shield, lance, axe, horse equipment, in addition to the seax; tools) and higher quantities than during young adulthood. All burials are furnished. The appearance of arrows in male burials ceases.	The character of the grave good assemblages remains the same as during young adulthood, and women receive high quantities and varieties of artefacts at this stage. However, the greatest proportion of unfurnished burials is found in this age category, in relation to furnished burials as well as all other age categories.
old middle adulthood (*c.* 36 - 45 years)	The character of the grave good assemblages remains the same as during young middle adulthood. Men receive the highest quantity and variety of artefacts overall, and all burials are furnished.	The character of the grave good assemblages remains the same, and women receive high quantities and varieties of artefacts. As equally as many women are buried with and without GG, this stage marks the appearance of the highest burial wealth for women.
mature adulthood (*c.* 46 - 59 years)	The character of the grave good assemblages remains the same as during middle adulthood, however, with a decrease in quantities of GG, as the greatest proportion of men buried without GG appears in this age category. The endowment with weaponry ends with this stage.	The character of the GG assemblage turns increasingly neutral, with the variety of artefacts remaining relatively high, but a drop in quantities. Fewer burials than during middle adulthood remain unfurnished, however, still more than in the male sample in this age category.
old adulthood (60+ years)	The character of the GG assemblage turns largely neutral, with the exception of masculine-gendered tweezers, but elaborate belt buckles may still occur. The greater proportion of burials is furnished.	Women are endowed with exclusively neutral artefacts, usually only 1 AT. The proportion of unfurnished burials is slightly lower than that of furnished ones, however, more women than men are buried without GG during old age.

[a] The term 'neutral' is used to designate artefact-types found commonly in male and female burials, according to the criteria established in Chapter 5.2.1. Differences in the object distribution in detail can be found in Table 8.2.
Key: GG = grave good, AT = artefact-type; yellow cells = liminal stage, light blue cells = age threshold, light orange cells = peak of burial endowment.

Age grades in the life course of a boy

A boy in Neresheim was born into a society that was subject to reverse rates of childhood mortality than noted at Pleidelsheim: many boys died during early childhood, more girls passed away during late childhood. The loss of boys this early appears to be perceptible in the relatively wealthy, albeit neutral grave furnishing they received (Table 8.3), as perhaps high expectations would have characterized his life course. The early redactions of the Alamannic law codes (see Chapter 3.2.3) that only speak of boys might find reflection in such an Alamannic society. Any perceived or expressed status conferred on the child was merely communicated in the burial wealth, not its engendering, as this may not have been necessary - the meaning of a male did not need emphasis, his passing away so very young however did. Apart from the fact that all recovered burials of young adult males were furnished, indicating once more the great social tension this caused to the social group, neither quantity nor character of the grave good assemblage implicates any allusion to either male gender or high regard in terms of status up to the onset of young middle adulthood (Table 8.3). It is possible that the burials of males in young adulthood depict a “reverse” transitional stage in a Neresheim man’s life - larger sample sizes may permit a conclusion on whether this phase marked the individual achievement of later status. Another possibility to consider is the absence of young adult males from the settlement during this life phase, in response to formative demands associated with active warriorhood.

Be that as it may, despite a different ‘run-up’, the primary age threshold is indicated for men in Neresheim at the same age as for those in Pleidelsheim; young middle adulthood marks the age of receiving the full set of engendered grave goods, principally weaponry and tools, replacing neutral items such as arrows which delineated pre-adulthood for a man in this society (Table 8.3; Table 8.2). Both weaponry and tools remain a constant accoutrement up to mature adulthood; with the exception of the latter category, all males are buried in furnished graves and, where items of weaponry, much more scarce in this population than in Pleidelsheim, are not included in a man's burial, tools or other artefacts appear to deputize for them. The death of a man in middle adulthood seems to manifest a great social loss expressed in the burial rite, much more emphasized than at Pleidelsheim, especially during old middle adulthood, which here represents a peak in burial accompaniment for men (Table 8.3). As the mortality risk is highest for a mature man in this population, it is possible that this effects the great percentage of unfurnished male burials occurring in this age category; a more noticeable social divide within the male group is also conceivable. However, the proposition of a divide between men still occupying an important social space within their *familia* and those already transferred to a less significant status with regard to the life in their social group - *not* with regard to their potential for active military service, given the persistence of weaponry in male burials up to mature adulthood (Table 8.3; Table 8.2) - seems more plausible in this society; with old age, men are buried completely gender-less again, with the occasional elaborate belt buckle being perhaps the only remaining symbol of male rank here.

Age grades in the life course of a girl

The high proportion of unfurnished graves and the much lower quantity of grave objects, compared to those accompanying a boy, in the burial of a girl who passed away during early childhood in Neresheim (Table 8.3) presages the considerably different female life course and status in this society. Only the survival through early childhood would elevate the status of a girl, as apparent by the burial endowment and style during late childhood (Table 8.3). The material construction of gender starts with adolescence, and, earlier than in Pleidelsheim, women appear to enter the status of a full adult in young adulthood (Table 8.3; Table 8.2). The large leap in terms of quantity and variety of artefacts bestowed onto a young woman compellingly underpins her significance and social importance for the society - and strongly alludes to her “marriageable” and reproductive abilities and thus biological sex. At the beginning of middle adulthood, women see a significant mortality risk, which coincides with not only the continued expression of social esteem in their burials, but also with the highest proportion of unfurnished graves encountered among the female sample (Table 8.3). Quite obviously, this phenomenon is not related so much to a change in social significance but rather to the high expenditure associated with a burial of a woman that age - certain families may not have been able to accommodate a sumptuous burial display, resulting in unfurnished graves when the loss was, presumably, personally one of the greatest. This indicates how female status in Neresheim was possibly very much related to that of her *familia*, and that there were, indeed, status distinctions unfolding through the circumstance of high female mortality. The comparison with male burials in the same age category (Table 8.3) belies the perception of men being of greater social significance for Neresheim society than women, as such distinctions in the burial rite are not observable within the male sample. That the social importance of a woman, however, would not cease towards the end of middle adulthood is revealed by the character of burial assemblages, which mark a peak during old middle adulthood (Table 8.3; Table 8.2), in a similar way to that observed at Pleidelsheim, however, with many women in Neresheim buried without any grave goods and, moreover, many interred in the most simple grave type. It is tenable that in this society, due to an earlier "start" of a family, a woman's role with regard to her social space within the *familia* starts to change earlier than at Pleidelsheim, and more women would receive no artefacts any more that indicate her social role or significance. It is only with old adulthood that the material assemblage turns completely neutral (Table 8.3; Table 8.2), thus the discrepancy in furnished versus unfurnished graves towards the end of middle and in mature adulthood must have a component of social status to it. Mature adulthood is, as for Neresheim men, a second age threshold, yet characterised by a visible change in gender roles. The material assemblage contains fewer items of bodily adornment and more pertaining to the household and its supervision (Table 8.2). Finally, women in old age seem to lose any social significance, given they survive into old adulthood, as not only are their grave inclusions, if any exist, completely gender-less, but also more women than men are buried in unfurnished graves.

Thus, a woman's importance to the Neresheim society was much more visibly tied to her biological abilities. Overall, age seems to have been an important factor with regard to the burial display, but lived identities were very much partitioned and determined by biological sex, while gender identity affected the lived status of an individual - and, in the case of males, certainly their abilities and social significance, depending on the stage in life in which they found themselves. Both would lose their social importance with old age, and their age thresholds seem to converge in parts:

Neresheim	
masculine thresholds:	I) [(i) 18 - 25 years] ii) *26 - 35 years*
	II) *old adulthood (60+ years)*
feminine thresholds:	I) i) puberty ii) *18 - 25 years*
	II) *i) mature adulthood* ii) old adulthood (60+ years)

Yet, while a woman's social role was much more tied to that of her group - *familia* or husband or both - the social role of a man was not only defined by his "able years", but very possibly, depending on the status which he attained, by his masculinity and associated success as well as duties towards his social environment. The unbalanced sex ratios of furnished and unfurnished graves in most age categories bespeak male social status as principally defined by acquisition through individual action.

The observation of the life course of men and women in Pleidelsheim and Neresheim reveal how, in both cases, the burial ritual emphasises something that in life was not the determining element of social functioning, and which could potentially conceal the social interactions of lives lived. In Pleidelsheim, the decisive element, or the dividing line between groups, was not sex and gender identity, but, besides partly social age, a combination of factors pertaining to social status. In Neresheim, age identity and with it the gain or loss of social importance seem apparent at first, but biological sex presents a vertical border and the key to social complexity in this population. In both societies, however, the burial ritual indicates that in its function as display, it served to present similarities and differences with other groups within the community.

8.1.3 As to the question of weaponry…

In the Alamannic settlements of Pleidelsheim and Neresheim, weaponry did not seem to simply symbolise male sex (cf. Halsall 2010b: 361), underlined by the fact that in neither society would boys be endowed with items of a weapon assemblage - barring seax and arrows, which in Pleidelsheim could be gender-associated during childhood, but which in both populations evidently exhibit an overall gender-neutral character (cf. Table 8.2; see Chapter 5.3). The *Leges Alamannorum* clearly describe the distinction between (the legal status of) boy and girl (Lohrke 2004a: 169f.), therefore the difference between them must have been of relatively great significance, as the character of the burial assemblage does not relate to neutrality in life on this measure. At Pleidelsheim, accompaniment with a sword in young adulthood may symbolise male legal majority, but then it would have to be set to around the age of 20, which seems late considering the descriptions of legal and relatively autonomous acting in the early teens (Lohrke 2004a: 169; see Chapter 3.2.3). Moreover, in Neresheim, the giving of weaponry as grave accoutrement is much more confined to young middle to mature adulthood; men from both populations only share the shield, an important piece of equipment as defensive or offensive weapon but probably not very highly prized (Frassetto 2003: 367), as clearly indicating the ages between *c.* 26 and 59 years.

That “weapon burials” straightforwardly denote the man in the “prime of his years” (Brather 2009), able to fight and holding pivotal positions with regard to family as well as social life within their local society, can also be disputed - for Pleidelsheim. At Neresheim, this might be part of the representational function of burials endowed with weapons as, all in all, power and influence as well as a certain achieved status during these stages in life might be conveyed. At Pleidelsheim, this can only partly be argued. The earlier appearance of noteworthy weaponry items such as a sword, as well as the occurrence of weaponry in old adult male graves does not agree with such a facile interpretation. Weaponry not only appears to denote male status much more than at Neresheim, but it is also possible that children asserted their own social position through the funerary display they granted their fathers (Gowland 2006) - and their mothers! - emphasising the significance of status as interwoven with kinship and achievement, but also possibly relating to the thought of honouring the elders who bestowed this social position which encompasses the notion of a "noble male" onto them (Bazelmans 2002). Giving and receiving weaponry seems ritualized to a much greater extent in this population than is the case in Neresheim, the display of weaponry in various combinations during young middle to mature adulthood referring to the potency of a male (Theuws 2009), as much as to his active abilities.

Weaponry as indication for…	***Pleidelsheim***	***Neresheim***
a) male sex	x	x
b) male legal majority	x	x
c) male "able[1] years"	[✓]	✓
e) male status and masculine identity - "warriorhood"	✓	[✓]
f) active warriorhood	[✓]	✓
g) entirely ritual act	✓	x

[1)]This includes the notion of fighting ability as well as being a leader or head of the *familia*.

8.2 Variables of biological and archaeological evidence: Mapping Alamannic social organization

8.2.1 Status and the Alamannic *social persona*

> *"Social structure is in itself an abstraction. It consists neither of graves nor of grave goods. These are the result of processes and structures whose existence can only be interpreted and explained as concepts."* (Hedeager 1992: 152)

At Pleidelsheim and Neresheim, elements of social structure are indicated in the burial rite and unfold in the reconstruction of the life course and the consideration of age and gender identity, but approaches to lived reality require the biological evidence of the people themselves. The skeletal remains as a primary source are a key to understanding the Alamanni and their lives, in combination with explored aspects from the mortuary context. What seems like an abstraction can become tangible, and interpretations of possible concepts can be offered.

The perception of an individual, and components such as their social age, by their group, i.e. an individual's social presentation within society, is certainly dependent on factors such as appearance and dress, but also very much on health and behaviour (Stauch 2008: 337). To this effect, it is compelling how the patterns of skeletal health and activity presented by the individuals in Pleidelsheim and Neresheim, in combination with the data indicated by the life course and fundamentals of societal complexity, permit and reinforce the suggestion of two different mechanisms for social organisation ruling these two populations, and reveal the potential for recognising and deciphering male and female status and social significance.

a) Pleidelsheim

At Pleidelsheim, the implications of biological age and sex as well as the burial custom help to establish a division of society that suggests a socio-economic basis relating to status that becomes even more apparent when consulting the skeletal evidence. Table 8.4 shows the occurrence of skeletal pathology and entheseal changes[119] according to age categories, placing the results obtained for patterns of skeletal health and activity in the context of the life course and providing an overview of the manifestation of pathological alterations in accordance with age.

At first glance, the overall male and female skeletal evidence displays a relatively high degree of homogeneity, although on closer inspection, variability is indicated by the differential occurrence of combined pathological patterns and differing ages during the life course in which some prevalences "peak" within the male and female cohorts, for instance, the occurrence of vertebral conditions such as Schmorl's nodes or spondylosis (Table 8.4). Males display a significantly higher prevalence of trauma, antemortem tooth loss, extra-vertebral DJD as well as Schmorl's nodes, spondyloarthrosis and osteoarthritis than females in this population. However, both osteoarthritic forms of degeneration can be found as especially prevalent during mature and old age (Table 8.4) and thus be considered sex-related phenomena which increase with age (Ortner 2003), the latter especially in the females, since these severe forms of joint degeneration were not observed before old middle adulthood (Table 8.4). DJD prevails in individuals of both sexes from very young age onwards (Table 8.4) but is particularly pronounced in males during young middle adulthood. For Schmorl's nodes, which indicate elevated levels of stress on the

[119] at young age, regarding the informational value of observations in young individuals and the age-related progression of entheseal changes as demonstrated in Chapter 7

spine and subsequent disc degeneration (Knüsel 2000a) and are also already present at a young age in males and females in Pleidelsheim, the highest prevalence rates in the male sample are found even earlier, in the early 20s, whilst presenting a more strongly age-related degenerative phenomenon in females (Table 8.4).

The greatest variance is recognisable with regard to patterns of physical activity as indicated by entheseal changes. While in general, the patterns uncovered point to a varied regime of habitual activities and potential differences in the sexual division of labour[120] (Molnar 2010), also suggested by the great number of significant correlations of entheseal changes with age in Pleidelsheim males (Table 8.4; see Chapter 7) which may stem from more intense physical activity in males overall (Wilczak 1998 ; Al-Oumaoui *et al.* 2004 ; Havelková *et al.* 2010), it is remarkable that Pleidelsheim females do not exhibit upper limb entheseal changes in young adulthood (Table 8.4). Males, on the contrary, display even higher frequencies of major entheseal changes at young rather than middle adulthood, and an overall concentration on activity of muscles attaching to the shoulder girdle and right upper limb, effecting adduction, abduction and rotation movements.

However, the fact that all females observed in the age category “young adulthood” were buried with grave accoutrements constitutes an important aspect, and the overall necessity to consider the data regarding health and activity separately for the ‘burial groups’ of individuals buried with grave goods (M / F GG) and without (M / F N GG) becomes evident.

[120] The overall result of higher mean muscle scores for entheseal changes in males, compared to females, as observed at both Pleidelsheim and Neresheim, joins similar findings in several studies on entheseal changes (e.g. Peterson 1998 ; Wilczak 1998 ; Eshed *et al.* 2004 ; Molnar 2006) and therefore sheds no further light on distinctive patterns of muscular activity.

Table 8.4: Pleidelsheim - Summary of observations regarding skeletal health and entheseal changes according to age categories

Age category	Males		Females	
	skeletal pathology	entheseal changes	skeletal pathology	entheseal changes
adolescence (*c.* 13 - 17 years)	maxillary sinusitis Schmorl's nodes DJD *os acromiale* (1 case)	more major EC than during middle adulthood <u>upper limb</u> bilaterally: *Mm. supra- and infraspinatus* right side: *Mm. lateral epicondyle* *M. pectoralis major* *M. deltoideus* <u>lower limb</u> bilaterally: *M. gluteus maximus* hip adductors and vasti muscles *M. soleus*	* DJD	<u>upper limb</u> no EC <u>lower limb</u> bilaterally: *M. soleus* right side: *M. gluteus maximus*
young adulthood (*c.* 18 - 25 years)	* Schmorl's nodes DJD trauma		* Schmorl's nodes DJD	
young middle adulthood (*c.* 26 - 35 years)	tibial periostitis spondylosis spondylolysis (1 case) Schmorl's nodes DJD (sign. more than females) trauma *os acromiale* (1 case)	significant correlation with age for 15 entheses (7 entheses in the upper, 8 entheses in the lower limb)	tibial periostitis spondylosis Schmorl's nodes DJD	significant correlation with age for 4 entheses (all upper limb)
old middle adulthood (*c.* 36 - 45 years)	tibial periostitis spondylosis spondyloarthrosis Schmorl's nodes DJD osteoarthritis trauma *os acromiale* (2 cases)		* tibial periostitis; maxillary sinusitis spondylosis spondyloarthrosis Schmorl's nodes DJD trauma (1 case)	
mature adulthood (*c.* 46 - 59 years)	** tibial periostitis; maxillary sinusitis spondylosis spondyloarthrosis (sign. more than females) Schmorl's nodes DJD osteoarthritis trauma		** tibial periostitis; maxillary sinusitis spondylosis spondyloarthrosis Schmorl's nodes DJD osteoarthritis trauma (1 case)	
old adulthood (60+ years)	tibial periostitis spondylosis spondyloarthrosis Schmorl's nodes DJD osteoarthritis trauma *os acromiale* (1 case) medial epicondylar avulsion fracture (1 case)		tibial periostitis; maxillary sinusitis spondylosis spondyloarthrosis spondylolysis (1 case) Schmorl's nodes DJD osteoarthritis	

Key: *no unfurnished burials occur; **largest proportion of unfurnished burials; highlighted blue = highest prevalence of pathology observed in this age category

Adult males and females buried *with grave goods* (GG) at Pleidelsheim are, in comparable measure, skeletally characterised by

- ☞ a relatively active life, **not** exempt from physical stress and strain;
- ☞ some childhood stress (developmental disruption);
- ☞ trauma patterns mainly associated with accidental trauma and weapon-related trauma in males;
- ☞ activity-related changes that exhibit a relatively high degree of sexual dimorphism and a different age of onset of observable entheseal changes (especially in the upper limb), increasing with age, however, **not** before middle adulthood.

A similar homogeneity is found in males and females buried *without grave goods* (N GG), who are marked by

- ☞ a very physically stressful and active life, including…
- ☞ … relatively similar activity-related patterns;
- ☞ childhood stress;
- ☞ susceptibility to non-infectious disease and accidental trauma;
- ☞ activity-related and degenerative changes throughout life, increasing with age.

In general, those individuals that do not show engendering artefacts (i.e. 'N GG') display poorer health and higher levels of physiological as well as physical stress than those found buried with grave accoutrements.

Table 8.5 lists a summary of highest prevalences[121] of skeletal and dental pathologies, respectively, among individuals in furnished and unfurnished graves. Except for those cases that are exclusive to one 'burial group' (highlighted in blue in Table 8.5), *all* males or females could suffer from any given pathological condition, regardless of 'burial group' (see Chapter 6), stressing the fact that there are no definite differences or distinguishing attributes that characterise either groups of biological sex or of "funerary status", i.e. grave furnishing. Still, the relative homogeneity in terms of skeletal health patterns of 'burial groups', rather than biological sexes, at Pleidelsheim is illustrated.

Table 8.5: Skeletal characterisation of individuals buried with and without grave goods at Pleidelsheim

PH M GG	**PH M N GG**
trauma	tibial periostitis[#], maxillary sinusitis
osteoarthritis	DJD (100%)
Schmorl's nodes	spondylosis
dental enamel hypoplasia	spondyloarthrosis
spondylolysis	*cribra orbitalia*
caries, peri-apical disease	periodontal disease, ante-mortem tooth loss
relatively high: DJD	*no* trauma, caries, peri-apical disease
PH F GG	**PH F N GG**
trauma	tibial periostitis, maxillary sinusitis
osteoarthritis	DJD
spondylosis	spondyloarthrosis**
Schmorl's nodes	*cribra orbitalia*
dental enamel hypoplasia	peri-apical disease, ante-mortem tooth loss
periodontal disease	
relatively high: DJD	*no* periodontal disease

Key: [#]tendency for significantly higher prevalence than M / F GG, */** significantly higher prevalence than M / F GG (*significance at p<.05 level; **significance at p<.01 level); highlighted blue = pathological observations exclusive to this 'burial group'

Any form of trauma, as well as cases of spondylolysis, can all be considered exclusive to 'M GG'[122], yet they are found distributed across the life course (Table 8.4). The composition of prevalent pathological skeletal alterations in 'M GG' suggests a high degree of physical activity, including a susceptibility to avulsion

[121] These are not necessarily statistically significant but gathered from the comparison of condition frequencies of skeletal pathological changes as presented in Chapter 6.

[122] Also caries and signs of associated dental decay are found exclusively in 'M GG', suggesting a higher intake of cariogenic food for those individuals buried in furnished graves at Pleidelsheim when additionally considering the phenomenon of periodontal disease in 'F GG'.

fractures in the vertebral column (i.e. spondylolysis, suggesting high levels of mobility involving the lumbar spine and indicating repetitive stress (Bridges 1989b), specifically lateral flexion (Fibiger and Knüsel 2005)) or the appendicular skeleton (e.g. *os acromiale*, in the majority of cases unilateral in this population) and patterns of trauma which, even though of accidental nature, are symptomatic of the involvement of strenuous activities (e.g. fatigue fractures to the metatarsals (Lovell 1997; cf. App. 6, Table 7)). The relatively early occurrence of the symptoms reveals their activity- and stress-related nature, albeit a continuation across the life course can be observed (Table 8.4). It is conspicuous, however, that young males in the group 'M GG' also show no evidence of upper limb entheseal changes, just like 'F GG', setting them apart from 'M N GG' with regard to this particular indicator that is usually the first to be associated with high levels of activity. As osseous changes to the upper limb are generally considered the best indicators to reveal differences related to activity, rather than loading (i.e. in the lower limb, Jurmain 1977 ; Bridges 1994), this finding can be considered as one of the most significant with regard to the differentiation of individuals in furnished and unfurnished burials. Given that osseous changes of muscle attachments would have already been developing at a very young age in those males buried without grave accoutrements, these individuals may have either tried to achieve certain rank associated with tasks requiring very strong physical endeavours, or - much more likely, considering generally higher levels of entheseal changes in 'M N GG' throughout life - were subject to different workloads altogether[123].

[123] The relatively higher frequency of tibial periostitis found in 'M N GG', observed from young middle adulthood onwards (Table 8.4) and mainly unilaterally, i.e. most likely due to localized trauma in males, may also support this assessment.

Such is also reflected when contemplating the skeletal changes in 'M GG': Schmorl's nodes and extra-vertebral DJD, appearing in relatively high frequencies (80% of cases) in 'M GG' and diagnosed predominantly in the shoulder girdle, hips, as well as wrists and hands, can already be observed in adolescent individuals and thus indicate physical stressors through activity rather than "wear and tear" with progressing age (Jurmain 1977); incidences of traumatic lesions appear from young adulthood onwards (Table 8.4). Around the early 20s (young adulthood), when males show a combination of these skeletal indicators of stress, none are found buried in unfurnished graves (cf. Table 8.1). This may indicate that only those skeletal alterations induced by high levels of physical activity and / or a specialized set of activities would show at such a young age, while stronger and more general signs of degeneration, evoked by more general demands of activity, for instance, would only show after continuous accumulation with the onset of middle adulthood (Table 8.4). If any status-related implications are presented in the nature of the funerary treatment, then it is possible that age identity over-ruled status identity in the funeral of a young adult male, and a biological distinction of status would be impossible to trace. That status may be an essential factor influencing the burial rite with the entry into young middle adulthood (Table 8.4), a now identified age threshold for males at Pleidelsheim (cf. Table 8.1), is potentially perceivable in the observation that after young adulthood, furnished and unfurnished burials occur in every age category, as do pathological changes of the skeleton that could characterise both 'M GG' and 'M N GG'. In fact, at this age category, a relatively sudden increase in frequencies of pathological indicators in male skeletal remains can be observed (Table 8.4), highlighting this significant age threshold with regard to status identity and its formation.

While not much more can be deduced from this line of analysis with regard to male social status, further consideration of the 'burial group' 'M GG' proves informative: the notion that these males as a cohort were subject to a comparatively high amount of physical stress is underlined by the positive correlation of osteoarthritis and spinal degenerative joint disease, and, furthermore, with the childhood stress indicator dental enamel hypoplasia. This gives rise to two possibilities for 'M GG': either they were indeed of higher status (i.e. born into higher ranking *familiae*) and thus survived shortages during childhood that caused hypoplastic defects, due to better living conditions including diet and / or care (Wood *et al.* 1992), or they were of lower status, surviving into adulthood but remaining more susceptible to physiological stressors during adult life (Goodman and Armelagos 1988).

One further positive correlation between a biological and a mortuary indicator for status appears, again shifting the significance of physical stress into focus for this group: the more artefact types in a male burial, the higher the susceptibility for DJD. Overall, males buried in furnished graves which, as adults, are also gendered graves, show signs of being exempt from generalized heavy workloads that could result in changes to the muscle attachments at a young age, but not of potentially more specialized activities causing skeletal degeneration that continues throughout life, with an intensification in stress levels related to burial wealth.

Such positive relationships between biological and social indicators of "status" (Robb *et al.* 2001) are much more direct and evident in the group 'F GG'. Females interred with artefacts are characterised by a combination of skeletal health markers very similar to their male counterparts (Table 8.5), with similar implications regarding the onset of degenerative changes and their relationship to age and activity (Table 8.4), including the possibility that the social importance of a woman during young adulthood weighs more than status identity with regard to the funerary treatment. Since between *c.* 36 - 45 years of age we find another phase in which all females are buried in furnished graves (cf. Table 8.1), and the combination of skeletal indicators of pathology (Table 8.4) may be age-related at this point and, as such, appear in all females, it is not clear whether the data imply another age bracket in which the social significance of a woman and her loss, thus, her age and gender identity (as the same does not apply to males at that age), over-rides any potential status distinctions otherwise demonstrable from the funerary context.

However, four pathological conditions are exclusively found in 'F GG' (Table 8.5), and important correlates between biological characteristics and burial wealth exist: trauma and osteoarthritis are exclusively common to females interred in furnished graves, even though both conditions only occur at a relatively late stage in life (Table 8.4). The same exclusivity applies to Schmorl's nodes, like extra-vertebral DJD appearing from young age onwards in 'F GG' (Table 8.4), the latter involving besides shoulders and hips more the elbow and knee joints in females, suggesting a slightly different stress distribution and potential workload compared to those of males. Spondylosis, indicative of more generalised mechanisms of vertebral degeneration (Ortner 2003), occurs from *c.* 26 years of age onwards in Pleidelsheim females (Table 8.4), a characteristic shared to a great degree also by 'F N GG' but still more typical for those found with artefacts. Thus similar patterns of skeletal stress factors occur in 'F GG' as found in 'M GG'. Yet, 'F GG' present an even more biologically distinct group, not least because it can be established that the taller a woman was, the lower prevalence of childhood stress prevailed, however, a higher susceptibility for vertebral degenerative disease in adulthood would be the case. This points to a coherent connection between favourable childhood conditions and thus potentially an environment of elevated status in early life, coupled with higher physical demands at later stages. Reviewing conditions uncovered in males, either the possibility of those showing similar correlations being born into lower ranking environments can be, in all likelihood, dismissed, or we are encountering two possible types of early-life status for males, while females display a lifelong association of skeletal health with social status.

The common lack of muscular markers of activity in males and females in furnished graves during young adulthood bespeaks a strong indication that grave furnishing could indeed generally relate to status for both sexes at Pleidelsheim. Females may show direct correlates of biological and social "status" (Robb *et al.* 2001) which eventually can be reflected onto the males. They display fewer direct interrelationships because their life course and associated status identity is much more strongly marked by elements of achievement in an open ranked society than that of females. This is also evinced by the positive correlation between the occurrence of dental enamel hypoplasia and grave goods, and, moreover, between body height and burial wealth in the female population of Pleidelsheim. Not only does this consolidate the association of skeletal health characteristics describing females in furnished burials, but it introduces an element that could not be observed for Pleidelsheim males nor any group at Neresheim: stature is generally hypothesised to be an indicator for status. Individuals of higher status are potentially taller due to an overall better nutritional and health status (Angel 1984 ; Cohen 1989 ; Schweich 2005) as well as, to a small degree, genetic predisposition (Obertová 2008).

Thus, despite an overlap of characteristics pertaining to skeletal health and patterns of activity in individuals buried with and without grave goods, the positive association of grave furnishing with female status at Pleidelsheim aids the recognition of similar status-related circumstances for males[124] and permits the clustering of males and females into groups that reflect a socio-economic divide in this society, rather than one based on gender or age identity, although these factors can over-ride status identity in the funerary context at certain stages.

With regard to earlier observations and now evidenced by archaeological as well as biological factors, the following simplified model for social functioning at Pleidelsheim can be proposed, with a horizontal divide between those individuals buried with and those buried without grave goods:

Pleidelsheim:		
	M GG	F GG
	M N GG	F N GG

In life, males and females do not differ by gender identity, but potentially by status identity and rank, only surpassed by other identities in the case of young adults for

[124] With regard to biological indicators, the circumstance of males being buried in chamber graves seems to assume some significance with regard to social status, although it is difficult to extract definite information regarding a possible association of status and grave type. The tendency for males, and individuals in general, found in chamber graves to be taller than others, as well as the overall lowest prevalences of vertebral DJD (except for Schmorl's nodes) is coupled with a relatively distinct pattern of upper limb entheseal changes for males in chamber graves as presented in Chapter 7. This presents a further confounding factor that demonstrates the potential ambiguousness of both archaeological and anthropological data with regard to status attribution.

both sexes. This is corroborated by the biological evidence and its differential reading (cf. Robb *et al.* 2001), placing males and females into homogenous groups relating to the funerary context, rather than to biological sex, and verifying the suggestion for an open ranked society (Steuer 1982a) at Alamannic Pleidelsheim, albeit *not* its more rigid and complex partition that resembles more hierarchic structures assumed for the Franks and later periods than the one under consideration and which is based on law codes and 'quality groups' (see Chapter 2.3). No such gradations are indicated by the available data. Instead, the shared occurrence of pathological conditions throughout life emphasises the mobility between ranks, in both males and females, which has been suggested for an open ranked society (Steuer 1982a); there are some direct correlates of biological and social "status" (Robb *et al.* 2001) in this society, reflecting a certain configuration of health for individuals in furnished burials that cannot be exclusive to this 'burial group' due to the nature of an open ranked society and its "fluidity" of status; and, most importantly, the character of this configuration of health and activity patterns suggests the notion of "effort" to achieve and maintain status.

Not the artefactual data, but the skeletal evidence allows us to trace social permeability and with it the most important feature characterising open ranked societies, that of achieved and ascribed status (Wason 1994: 45). Both males and females had to literally "work hard" to not only attain their rank, but to keep it. Regarding the skeletal evidence, this contradicts the customary notion of high(er) status entailing reduced workloads[125] (e.g. Larsen 1997: 178f.), i.e. less physical stress. However, with regard to Fried (1967) who notes that individuals holding

[125] This hypothesis, however, stems primarily from the analysis of prehistoric stratified societies (Larsen 1997) and has only been adopted as a more universal principle.

certain ranks would be rather “compelled to work more arduously than anybody else, because [they are] expected to be more generous in [their] distributions” (Fried 1967: 114f.), and considering the findings for ‘M / F GG’ at Pleidelsheim, it concurs with the bioarchaeological evidence and provides a substantiated characterisation of mechanisms describing *open ranked societies*.

As to the question of inherited and acquired status, the data propose that at Pleidelsheim, individuals would be born into a *familia* of certain rank - for males, this *may* have been the case, for females, it certainly was - but adult life would be marked by endeavours and efforts to maintain it[126] (Porčić and Stefanović 2009). With regard to “social action”, rights, duties and also access to resources that could be associated with rank (within the *familia* and between household groups) and status identity (Larsen 1997), women may have maintained rank similarly to the men, either by association with them or among themselves and within the local society, hence the obliteration of gender differences in life. However, status seems to have been more pre-assigned for women than for men, possibly due to male “proclivities” (i.e. the potential to prove oneself through certain qualities and achievements) that would also resonate in the meaning of weaponry and its reception in the funerary context of this society[127]. Indeed, the aforementioned social significance of females (see Chapter 3.2.3), thought to be solely indicated in the *wergild* sums and funerary treatment, is endorsed by the present findings, as the biological and archaeological variables suggest that women of the group ‘F GG’

[126] Females may show similar indicators of physical stress during adulthood compared to males, as in this society, their potential higher status of their *familia* or rank within the *familia* would not have entailed the “recruitment” of labour on their behalf, at least not recognisably so within the cohort of ‘F GG’. Single cases of such a constellation may be possible, or the supervision of tasks by higher-ranking females of a certain age, rather than their direct involvement.

[127] Considering the importance of the *familia* (Steuer 1892a) as well as associated bonds of kinship and ‘war bands’, elements characterising non-ranking societies (Wason 1994: 41ff.), it is possible that the men of this society were still bound to (potentially) pre-existing characteristics of tribal structures, especially given a likely involvement in warfare, while shifts in social complexity towards a more stratified society were indicated earlier in the females of Pleidelsheim.

grew up in *familiae* that could afford higher investment in girls, which reflects the achievement of the ideal of high esteem placed upon them with regard to their future potential in forging and maintaining bonds among *familiae* and for the society, coupled with the conception that those women of higher rank would provide 'role models' later in life - potentially up into old age.

The recognised division between individuals with and without burial 'wealth' indicates that the society of Pleidelsheim may have been moving towards a more stratified society[128] that would have been instated at the time of the later redactions of the *Leges* (i.e. late 7th and early 8th century onwards), given that those buried in unfurnished graves represent a relatively distinct economic group (Robb *et al.* 2001), even though not entirely removed from the possibility of social movement. Again, similar to the previously described indications for changes in social functioning interpreted from the artefactual evidence, all evidence points to a society that shows structures heralding later socio-economic conditions, apposite to Merovingian principles and practices.

b) Neresheim

In Neresheim, the skeletal evidence initially presents a very different picture to the conditions revealed in Pleidelsheim. The entire population, males and females alike, is marked by a higher prevalence of physical and physiological stressors in childhood and later in adulthood, including oral pathologies such as, for instance, ante-mortem tooth loss that may be caused by varying nutritional and / or

[128] Bintliff (2008) remarks that a population's control over trade as well as the availability of prestige goods would form a component for social stratification - both elements are characteristic for the settlement of Pleidelsheim (see Chapters 2 and 4.1).

behavioural patterns as well as a multitude of systemic pathological influences (Hillson 1996; 2008). Trauma patterns differ from those at Pleidelsheim, not only in their distribution between the sexes (females have a much greater propensity for trauma at Neresheim), but also in their nature. Thus weapon-trauma is completely absent in this population, indicating that individuals involved in interpersonal conflicts (predominantly warfare) were not buried in the settlement cemetery but probably died away from their homestead; clavicular fracture patterns in males are distributed more randomly than those in Pleidelsheim males who display mostly clavicular midshaft fractures (see Chapter 6.1.2). Females display a high frequency of lower limb trauma, especially involving the tibia, which has been connected to activities such as dairy farming (Judd and Roberts 1999), for example, and the nature of trauma encountered in this settlement overall concurs to a high degree with that described for intensive farm life (Judd and Roberts 1999).

A harder life endured by those at Neresheim, compared to the situation at Pleidelsheim, stems from the relatively harsh environment with its challenges for agricultural activity that is thought to have been the mainstay of this society, far away from trade routes and exchange (see Chapter 4.1.2). This is also reflected in the analysis of osseous changes induced by muscular strain. Both males and females at Pleidelsheim show entheseal changes from young age onwards with a gradual increase towards old adulthood, and with only few exceptions, the overall patterning and generally relatively high frequency of activity-related changes does not differ to a significant degree. Diversity in levels and distribution of muscle strain distinguishing males and females also characterises this population, suggesting not only local heterogeneity for Neresheim in general but moderately differential patterns of workloads between men and women. It is interesting to note here that strong physical strain by repetitive motion of the pectoralis muscles, primarily generating arm flexion and medial rotation, is common to the males in both populations, while patterns of entheseal changes in females at Pleidelsheim and Neresheim suggest a higher repetitive involvement of the rotator cuff muscles (i.e. shoulder stabilisers, see Chapter 7), hence, varying patterns of physical strain are reflected in the upper limb which indicate potential labour patterns distinct for Alamannic men versus women. Entheseal changes in the lower limb connote an agricultural society, similar in this aspect to Pleidelsheim and substantiating the hypothesis of an essentially common type of subsistence economy, as not only do the entheseal changes demonstrate relatively great diversity and variability (see Chapter 7), but a very low degree of sexual dimorphism, which has been associated with societies based on agricultural activity in the past (Wilczak 1998 ; Al-Oumaoui *et al.* 2004 ; Havelková *et al.* 2010). Nonetheless, in all cases the results obtained reflect a multitude of possible activities that would be almost impossible to differentiate with regard to specific patterns, and a strenuous lifestyle for both sexes at Neresheim can be inferred.

A look at the distribution of pathological alterations as evidenced by the skeletal evidence arranged according to age category (Table 8.6) reveals homogeneity at a high level in this population. With the exception of young adult males, who display evidence of stress-related disease patterns suggesting intense repetitive strain and movement (with the small sample size kept in mind, joint disease in the vertebral column and appendicular skeleton as well as avulsion fractures could be observed (Table 8.6)), the occurrence and prevalence of skeletal pathologies takes a similar course in Neresheim males and females, with a peak for all observed conditions except for non-specific stress indicators (tibial periostitis and maxillary sinusitis) in mature or old age (Table 8.6), thus confirming a natural age-related progression of “wear and tear”.

Table 8.6: Neresheim - Summary of observations regarding skeletal health and entheseal changes according to age categories

Age category	Males: skeletal pathology	Males: entheseal changes	Females: skeletal pathology	Females: entheseal changes
adolescence (*c.* 13 - 17 years)	-	upper limb bilaterally: *M. pectoralis major* right side: *M. subscapularis* *Mm. supra- and infraspinatus* *M. deltoideus* left side: *Mm. lateral epicondyle* lower limb bilaterally: *M. soleus* right side: *M. gluteus minimus* left side: *M. gluteus maximus*	* tibial periostitis (1 case, unilateral)	upper limb right side: *M. subscapularis* *M. pectoralis major* *M. biceps brachii* lower limb left side: *M. soleus*
young adulthood (*c.* 18 - 25 years)	* spondylolysis (1 case) Schmorl's nodes [DJD?] trauma (1 case) *os acromiale* (1 case)		* maxillary sinusitis	
young middle adulthood (*c.* 26 - 35 years)	* tibial periostitis; maxillary sinusitis spondylosis spondylolysis (2 cases) Schmorl's nodes DJD	significant correlation with age for 8 entheses (4 entheses in the upper, 4 entheses in the lower limb)	** tibial periostitis; maxillary sinusitis spondylosis Schmorl's nodes DJD trauma *os acromiale* (1 case)	significant correlation with age for 1 enthesis (lower limb)
old middle adulthood (*c.* 36 - 45 years)	* tibial periostitis; maxillary sinusitis spondylosis Schmorl's nodes DJD trauma *os acromiale* (1 case)		tibial periostitis; maxillary sinusitis spondylosis spondyloarthrosis spondylolysis (2 cases) Schmorl's nodes DJD osteoarthritis trauma *os acromiale* (1 case)	
mature adulthood (*c.* 46 - 59 years)	** tibial periostitis; maxillary sinusitis spondylosis spondyloarthrosis Schmorl's nodes DJD (sign. more than in females) osteoarthritis trauma		tibial periostitis; maxillary sinusitis spondylosis spondyloarthrosis Schmorl's nodes DJD osteoarthritis trauma	
old adulthood (60+ years)	spondylosis spondyloarthrosis Schmorl's nodes DJD osteoarthritis trauma (1 case) *os acromiale* (1 case)		tibial periostitis spondylosis spondyloarthrosis spondylolysis (1 case) Schmorl's nodes DJD osteoarthritis trauma	

Key: *no unfurnished burials occur; **largest proportion of unfurnished burials; highlighted blue = highest prevalence of pathology observed in this age category

With regard to entheseal changes, the quite varying patterns of upper limb activity-related skeletal alterations in young adult males and females (Table 8.6) are of some interest, as they reveal a close association of patterning for young males in Pleidelsheim and Neresheim with higher involvement of the (mainly right-side) rotator cuff muscles in Neresheim males as well as of the wrist extensors of the left, rather than the right hand (Table 8.4; Table 8.6; see Chapter 7). Females at Neresheim display an intense, repetitive and continuous strain on muscles of the right upper limb, including recurring elbow and forearm flexion and supination as well as medial rotation and adduction movements of the arm that sets them apart from young males (Table 8.6) and appears to form part of a persistent movement pattern for them throughout life (see Chapter 7). This is supported by the evidence for DJD especially affecting the right shoulder and elbow in females at Neresheim (see Chapter 6.1.2), albeit signs of joint degeneration are only apparent from young middle adulthood onwards in this female population (Table 8.6), in contrast to those in Pleidelsheim.

The most substantial and meaningful differences, however, characterising the population of Neresheim and signalling indicators of social disparity and status are only revealed when considering health and activity-related skeletal changes by 'burial group' (M/F GG/N GG). They contrast with the results from Pleidelsheim, pivoting around another determinant, namely biological sex.

Table 8.7: Skeletal characterisation of individuals buried with and without grave goods at Neresheim

NE M GG	NE M N GG
(maxillary sinusitis) (*cribra orbitalia*) spondylolysis	tibial periostitis trauma DJD osteoarthritis (100%)* spondylosis spondyloarthrosis Schmorl's nodes (100%) dental enamel hypoplasia (100%)
	no maxillary sinusitis, periodontal disease
NE F GG	**NE F N GG**
maxillary sinusitis trauma osteoarthritis spondylolysis dental enamel hypoplasia periodontal disease caries	tibial periostitis DJD spondylosis spondyloarthrosis Schmorl's nodes *cribra orbitalia* ante-mortem tooth loss
relatively high: DJD	*no* periodontal disease

Key: */** significantly higher prevalence than M / F GG (*significance at p<.05 level; **significance at p<.01 level); highlighted blue = pathological observations exclusive to this 'burial group'

The summary of skeletal and dental pathologies discerned in each 'burial group' at Neresheim, again based on the highest, albeit not necessarily statistically significantly divergent prevalences of any given condition in individuals buried with and without grave goods, illuminates how the range of conditions distinct to one or the other 'burial group' is greatly diminished in comparison to what was observed at Pleidelsheim (Table 8.5; Table 8.7). All individuals, whether buried with artefacts or not, were susceptible to any given pathological condition, except for spondylolysis which seems to be a discrete trait of individuals buried in furnished graves (Table 8.7). Despite the overall relatively high stress levels for males and females in this population, greater measures of physiological and physical stress are also illustrated in Neresheim as characteristic for those individuals buried without any grave accoutrements and therefore without any gendering artefacts. Particularly striking, however, is not a distinction into 'burial groups' with regard to a more discrete patterning but a visualization of those elements that distinguish males and females, especially those buried with grave goods (Table 8.7).

Adult males at Neresheim are characterised by

- ☞ slightly better skeletal health of males buried in furnished ('M GG') than males in unfurnished graves ('M N GG');
- ☞ relatively congruent patterns of skeletal health and entheseal changes for all males;
- ☞ activity-related osseous changes indicative of physical activity from early adulthood onwards;
- ☞ no weapon-related trauma;
- ☞ no positive correlates between archaeological and biological variables[129].

Adult females at Neresheim are marked by

- ☞ very similar patterns of skeletal health and physical stress in females buried with and without grave goods, the latter exhibiting generally higher stress levels;
- ☞ patterns exhibited by females in furnished burials ('F GG') largely congruent with Pleidelsheim females buried with grave goods, but more physically stressed;
- ☞ no positive correlates between archaeological and biological variables.

The strong similarity with regard to skeletal pathological alterations in individuals at Neresheim complicates discerning subtle variation between groups, at the same time testifying to the similarities of environmental and lifestyle requirements of this population. Recognising meaningful variation with regard to an interpretation of social complexity may seem difficult but can still be accomplished by carefully contextualizing the data.

[129] The positive correlation between the burial accoutrements of a sword and entheseal changes in *Mm. supra- and infraspinatus* (see Chapter 7) relates to the 'burial group' 'M W' ("weapon burials") and will be discussed forthwith.

The "better health" status of 'M GG', compared to all other groups at Neresheim (Table 8.7), is deceptive in two ways. Firstly, males found buried in furnished graves are not marked by "good health" but by patterns of skeletal health and activity a) not very different from the those of males at Neresheim in general, and b) rather different from those uncovered for 'M GG' at Pleidelsheim[130] (cf. Table 8.5). Not only did *all* pathological conditions affect 'M GG' and 'M N GG', but vertebral joint disease, indicators of childhood stress, dental decay or tibial periostitis show no noticeable differences between the two 'burial groups', merely a marginally lower frequency in 'M GG' (see Chapter 5.2). Males buried in unfurnished graves solely show a perceptibly higher susceptibility to extra-vertebral DJD, osteoarthritis, and trauma (Table 8.7), conditions that are observable from young middle adulthood onwards in Neresheim males (Table 8.6), an identified age threshold (cf. Table 8.3).

Secondly - and this elucidates the above - *all* males were buried with grave accoutrements from *c.* 18 - 45 years of age (Table 8.3), i.e. the 'burial group' 'M GG' comprises all males up to mature adulthood. The group 'M N GG' does not exist for males before that age. Thus, in the age category that also sees a sudden division of males buried in furnished and unfurnished graves, and therefore ungendered manner (cf. Table 8.3), a comparable sudden division into status identity can be inferred. Mature adulthood describes the age category with which not only a natural, age-related increase in skeletal pathologies is evident but, more importantly, a "peak" of skeletal conditions that typify 'M N GG' in the severity of symptoms (Table 8.6). It is therefore difficult, if not impossible, to identify an evidence-based distinction in male social status on the basis of "biological status" in

[130] This also applies to 'M N GG', as the observations for trauma, osteoarthritis, Schmorl's nodes and dental enamel hypoplasia are at variance with 'M N GG' at Pleidelsheim (Table 8.5; Table 8.7).

Neresheim, unless it is assumed that relatively “healthy” males, of higher rank (*not* described by their funerary modus), did accumulate pathological skeletal changes less strongly with age than those of lesser rank, due to increased intensity of stress in the latter group. It is furthermore possible that the high frequencies of pathological symptoms are heavily age-related due to the more austere living conditions for people in this settlement, and thus a distinction into ‘burial groups’ on the basis of skeletal health patterns cannot be accomplished for Neresheim males.

From young to old middle adulthood (therefore including age identity), male biological sex and gender identity appear to have been such important concepts to life within the Neresheim society that they either over-rode status identity as expressed in the funerary rite, or, much more likely, were associated with a concept of masculinity as expressed in gendered grave goods, i.e. weaponry, coupling male identity with a strong notion of achievement and potentially recognition for Neresheim males. The skeletal evidence for young adult males (between *c.* 18 - 25 years) corroborates this impression, considering the observed skeletal alterations that indicate intense mechanical stress of activity-related nature (cf. Bridges 1989a ; Larsen 1997: 191ff.), and elucidates the previously noted “reverse” liminal stage for young Neresheim males: *if* achievement mediates the attainment of certain rank and status, the observable combination of skeletal changes indicating “physical effort” in young adult males - completely lacking in females in the same age category - may point to the greater exertions of men at that age, before receiving “approbation” in young middle adulthood, visible in the mortuary environment.

Due to the small sample size for young males at Neresheim, this can only remain a hypothesis, however with a strong, evidence-based footing for future investigations. With the onset of mature adulthood, age and gender identity appear to be transcended by a combination of age and status identity, with gender identity fading into the background and eventually disappearing completely with old age (cf. Table 8.3). It can be demonstrated that the observed pathological changes in this age category (Table 8.6) are constituents of males of both higher and lower rank, should the interment with or without grave goods be meaningful to that extent, and that the recorded occurrence of elaborate belt buckles (cf. Table 8.3) may be associated with males who attained a certain rank and maintained their status identity into old age.

Therefore, two aspects mark social dynamics for males at Neresheim: the strong commonalities of patterns of skeletal health and activity emphasise a very (physically and socially) mobile society for males, while biological and archaeological evidence considered jointly signify the importance of achievement with regard to social identity and status for this group. Interestingly, Neresheim males form a group where the burial in chamber graves may have had some significance for status identity, as there are trends for males interred in this grave type to show the lowest prevalences of most pathological conditions, with the exception of trauma as well as maxillary sinusitis. The latter is in stark contrast to females at Neresheim as well as to males at Pleidelsheim, however, in congruence with females buried with grave goods at Pleidelsheim, hinting at a potentially common living environment causing respiratory ailment[131] in these two groups, for instance, indoor conditions or certain (agricultural subsistence?) activities acting as a sinus irritant (Roberts 2007). Moreover, males buried in simple graves not only show the greatest artefact absence in this population (see Chapter 6), but also the highest prevalence of many examined skeletal conditions such as DJD, not, however, the highest mean muscle scores (MMS). Altogether, one archaeological indicator correlating with biological indicators of status might be given if it could be substantiated by a larger sample size, albeit only indirectly.

The first conspicuous variation in skeletal health characteristics among the groups in Neresheim (Table 8.7) emerges not with regard to the males, but in the females. As in males, no condition of either skeletal health or indicators of activity and physical stress are exclusive to 'F GG' (with the exception of spondylolysis) or 'F N GG' (Table 8.7), no direct correlations could be observed with regard to biological and social "status", including the component 'stature', and a clearly differentiated pattern of health and activity, as in Pleidelsheim (Table 8.5), is absent. As in Neresheim males, the difference in prevalence between conditions listed as mainly characterising 'F GG' or 'F N GG' (Table 8.7), such as tibial periostitis, DJD, osteoarthritis and spondylosis, as well as dental disease and childhood stress indicators, do not display a statistically significant and, in most cases, not even remarkable polarity for either 'burial group' (see Chapter 6). Among 'F N GG', merely the positive correlation of DJD and *cribra orbitalia* indicates that a less favourable childhood would have entailed a more physically demanding adulthood.

[131] A correlation of maxillary sinusitis and dental disease could not be found in this study, making a dental origin of maxillary sinusitis (Roberts 2007) rather unlikely for the examined groups.

This overlap of skeletal health characteristics indicates very similar living conditions and physical demands for females at Neresheim, regardless of rank or status.

Nonetheless, a greater range of pathological conditions can be registered with highest prevalences for the group 'F GG' than was the case for males (Table 8.7), and closer inspection reveals a great degree of congruency of those pathological conditions in 'F GG' in both populations, Pleidelsheim and Neresheim (Table 8.5; Table 8.7), with the only exception of maxillary sinusitis, in Neresheim commonly found in females interred in furnished burials, although never in chamber graves, contrary to findings in the male sample. Females in Neresheim may have had a greater propensity than those in Pleidelsheim to develop higher frequencies of most conditions of physiological and physical stress, and lived with an elevated risk of skeletal injury, but nevertheless, the composition of pathological conditions as detectable in 'F GG' is key, especially in conjunction with the mortuary evidence.

In adolescence and young adulthood, the only age categories in which all Neresheim females were buried with grave goods (cf. Table 8.3) and which constitute important stages in the life of a woman in Neresheim society, no joint disease or trauma could be discerned, only the onset of aforementioned activity-related changes to the entheses of three upper limb and one lower limb muscles (Table 8.6)[132]. At the beginning of middle adulthood, i.e. with the mid-20s, a significant change is notable with regard to skeletal pathologies (Table 8.6) that coincides with the previously detected status distinctions suggested by a change of circumstances in the funerary behaviour (cf. Table 8.3). Females at young middle

[132] While the appearance of tibial periostitis and the "peak" of maxillary sinusitis at very young age in Neresheim females is somewhat intriguing, the small number of cases in which these conditions are manifest in the age categories unfortunately does not permit any further interpretation.

adulthood display almost the complete range of pathological observations, the absolute range at middle adulthood (Table 8.6). A meaningful partition of status at young middle adulthood, conveyed by archaeological evidence, is substantiated by the biological evidence, as it is distinctly possible that those females buried without grave goods display those patterns of skeletal health attributed to the 'burial group' 'F N GG' (Table 8.7), forming a definable (status-) subgroup emerging in this age category and persisting forthwith.

With continuing middle adulthood, the appearance of greatest burial 'wealth' in female furnished graves as well as the relatively even distribution of furnished and unfurnished female burials (Table 8.3) coincides with the altogether highest range of observable pathological changes (Table 8.6), thus constituting a "biological threshold" in terms of potential differentiation of 'F GG' and 'F N GG' and therefore with regard to status identity at old middle adulthood. The status and (potentially higher) rank of those women buried with engendering artefacts at this age, showing a pattern of skeletal health and physical stress at variance with those of other (possibly lower) rank, may be closely linked to male status as well as kinship, considering that no further indicators for female attainment of status are provided by the mortuary and skeletal evidence in this population. It is the correspondence with the findings from an Alamannic society such as Pleidelsheim, in which the group 'F GG' shows more explicit correlations with status, which consolidates the distinction of females buried with artefacts as of different status to those in unfurnished graves. Those elements that explicitly indicate high levels of physical stress in the group 'F GG' (Table 8.5) do not appear in the compilation for 'F GG' in Neresheim (Table 8.7), yet they are by all means present in these females, and the large number of positive correlations between skeletal variables found in Neresheim females (see Chapter 6) highlights the exposure to high levels of physical stress throughout life and irrespective of 'burial group'[133]. It may be of noteworthiness, however, that the co-occurrence and coaction of all skeletal conditions particularly evident at middle adulthood (Table 8.6) may indicate an increased exposure to circumstances causing physical strain (e.g. workload) for Neresheim women within this age category that might be potentially linked to an absence of males, an hypothesis that will be discussed forthwith.

Overall, age and gender identity are transcended earlier than observed in Neresheim males by a combination of age and status identity in the funerary rite of the female population, with status identity itself formed by sex and age identity and the mortality risk involved, as well as by kinship relations. Status identity in this population appears to be significant enough to *not* be over-shadowed by age and gender identity, as could be hypothesised for Pleidelsheim females (particularly at old middle adulthood). This implies that females may have acted as a "carrier" for status display in the burial rite at Neresheim, emphasising the demonstration of rank in the funerary rite as a means to express a *familia's* status within the local society, in a population in which the availability of material artefacts (whether generally or destined for burial accoutrement) was restricted and the necessity to display rank of high importance for the competition for status and associated societal importance, characterising an instable, (open-) ranked society (Childe 1945 ; Wason 1994: 85).

[133] Regarding this notion, see also Fried (1967: 114): "A distinctive feature of the ranking society is the employment of all individuals in labor tasks typical of their age and sex. Rank does not bring assignments that take its possessor out of the regular labor force, nor does the manipulation of rank suffice to excuse the manipulator from regular tasks."

Male gender and the associated proclivities and prowess may have been too important to not bury men of certain ages without grave goods, despite the existence of different ranks and status identities within the male part of society. It is conceivable that all males between young middle and mature adulthood were considered able to defend this settlement in the periphery of the Alamannia and the Frankish Empire and were therefore shown higher appreciation[134], and / or they constantly moved between ranks on the basis of their achievements. Females, however, may represent more "stationary" conditions, both with regard to their physical presence within the settlement as well as to their potential to form bonds between social groups (e.g. *familiae*, by marriage and child-bearing ability) and thus maintain rank and sustain status, highlighted in the burial rite up to old middle adulthood at Neresheim. This also underlines the female function within the *familia* and the social group noted before for women of that age at Pleidelsheim and provides a possible explanation for the nature of the female social role and continued social importance at this stage of life, which in Neresheim subsequently declines with increasing age and old adulthood. It could be hypothesised that surviving males would now present insignia of rank, if maintained, on their funerary bed, while in females, this would not be imperative due to their association of status with males, and the principle of "achievement" was of little relevance to their lives and status relations. Be that as it may, the biological evidence cannot provide any further clues of status here due to its incremental nature with old age.

[134] This may be also indicated by the higher "visibility" of males in the archaeological funerary record (cf. Arnold 2008): despite a greater proportion of adult females in the demographic record of Neresheim (cf. Chapter 5), males from young middle adulthood onwards are more often buried in furnished graves than are females (cf. Table 8.3) and their gender identity therefore comparatively more manifest, as measured by the presence of engendering grave goods.

Indirectly, also at Neresheim, status complexity can be explored through the females, even though in this case, biological indicators for status coincide only indirectly with mortuary indicators. The biological evidence could corroborate what became apparent in the investigation of the burial practice and its constituents but still remained rather clouded by the sways of ritual. Biological sex does indeed constitute a vertical border, as this simplified model below shows, trailing gender and age identity as well as status identity and defining social complexity and interaction in the Neresheim society:

Neresheim:		
	M GG	F GG
	M N GG	F N GG

At Neresheim, gender and age of males and females contributed to their position in life and local society, with social roles and status communicated in the burial rite, in males overshadowed by expectations of achievement and recognition of esteem and *a fortiori* expressed in females.

The environment of Neresheim and subsistence requirements of daily life would have posed the same risks for childhood stress for all children and demanded similar efforts and workloads from both adult males and females in terms of physical stress (Fried 1967: 115; Wason 1994: 42). Therefore, indicators of skeletal health and behaviour display great homogeneity in this population, potentially obscuring distinctions between 'burial groups' more clearly discernible in Pleidelsheim, and pointing to generally low levels of stratification. There are no immediate indications with regard to the question whether individuals were born into *familiae* of certain rank or not, but it is plausible, given the strong associations with kinship implicated for females.

The divide between genders is all the more pronounced, however, when considering the fact that the mechanisms of an open ranked society, marked by achievement and status acquisition (Steuer 1982a ; Wason 1994: 45ff.), appear to have been confined to males, with a strong notion of competition for prestige already early in life. Yet, any possible status differentiation, as in Pleidelsheim, can only be interpreted from the female sample, because biological sex is the decisive element, not a socio-economic or, more generally, an *a priori* status-divide. Neresheim women did not subject themselves to great physical efforts and a strenuous life to achieve and maintain rank, but primarily to ensure subsistence; their rank and status were closely tied to that of males and / or their social group, and "achievement" as a component of differing status in an open-ranked society was, in principle, a male matter. The boundary towards females was not emphasised in the funerary rite as it did not matter socially, considering that it existed as a "given"; the emphasis on status within the gender groups was what required display. Considering how much male status at Neresheim seems to have been characterised by the association with weaponry and its direct as well as symbolic implications, an affiliation to warriorhood-related lifestyle is palpable, shifting the Alamannic society of Neresheim closer to a society based on "tribal" or chiefdom structures than towards a stratified society (Wason 1994: 48ff.; Steuer 2004), with an uncontested presence of ranking structures, however also here *not* necessarily dividable into categorisations such as "high" and "low" status (see Chapter 2.3).

8.2.2 As to the question of warriors…

The question whether Alamannic males buried with weapons were indeed synonymous with warriors, and the notion of "warriorhood" in its physical and social reality in Pleidelsheim and Neresheim can only be conclusively approached in relation to the findings pertaining to other social identities (Vandkilde 2006c: 395) and their significance for the lives and social space of males in those two populations. Following up the exploration of potential meaning of weaponry in Alamannic burials, the skeletal evidence set within the context of social mechanisms permits insight into the idea of Alamannic "warriorhood",

> *"… a social identity which is created through the social processes of war and which is nourished on warfare as a social action."* (Vandkilde 2006c: 403)

This definition of "warrior identity" may well apply to individuals at Pleidelsheim and Neresheim, considering the *communis opinio* of Alamannic ethnogenesis to have developed on the basis and in the aftermath of violence and warrior bands during the 3rd to 5th centuries AD (Steuer 1989; 2006 ; Vandkilde 2006a). However, a characterisation of Alamannic warriorhood between the 5th and 7th centuries, in fact, up until the hierarchisation of society when hegemonised by the Carolingian empire, remains fragmentary[135], the question of the significance of "weapon burials" remains unsettled (Steuer 2006). Do males in "weapon burials"[136] testify to institutionalised warriorhood in the societies of Pleidelsheim and Neresheim

[135] "The movement from warrior band to empire or territorial government always follows a pattern of which the individual stages cannot - or at best in some stages only - be archaeologically recognised." (Steuer 2006: 234)

[136] As this study has shown, "warriorhood" should be explored among the male population, as the endowment of female burials with items of the range "weaponry", i.e. seax and arrows, can be considered either of functional or symbolic nature, pertaining to status (cf. Chapter 5). Considering the question of the actual use of certain items as weapons (e.g. seax, cf. Chapter 5), Theuws (2009) argues for a cautious use of the term "weapon burial", which is also followed here.

(Vandkilde 2006c), including the suggestion of males as warriors in a retainership (*Gefolgschaft,* Steuer 1982a: 54ff.; Steuer 1992), were they all “peasant-warriors”, or does the weapon endowment attest to an idea of masculinity in the framework of age and gender identities, establishing “warriorhood” as a social identity as part of the life course (cf. Chapter 3.2)?

While the archaeological evidence considered in the context of the life course has already provided some indication of the potential and functional meanings of weaponry in male burials, the biological evidence strengthens the possibilities for interpretation, as it provides the following descriptors for males in “weapon burials” (‘M W’):

At *Pleidelsheim*, ‘M W’ show

- ☞ **no** statistically significant positive correlation with stature;
- ☞ patterns of skeletal health and activity-related changes that essentially equate to that of ‘M GG’…
- ☞ … with the exception of **weapon-related trauma**;
- ☞ **no** entheseal changes in the upper limb before young middle adulthood;
- ☞ no positive correlation of weapons with entheseal changes;
- ☞ patterns of entheseal changes potentially indicating habitual weapon-use (e.g. right rotator cuff muscles, common extensors of hands and fingers) found instead in males buried without weapons (‘M NW’).

‘M W’ at *Neresheim* display

- ☞ **no** statistically significant positive correlation with stature;
- ☞ patterns of skeletal health at variance to ‘M GG’ and comparable to Pleidelsheim ‘M W’:

- relatively high prevalence of trauma (but **no** weapon-related trauma);
- skeletal injuries associated with high levels of activity from young age onwards;
- relatively high prevalence of joint disease and maxillary sinusitis;

☞ distinctive pattern of upper limb entheseal changes from young adulthood onwards;

☞ positive correlation of entheseal changes (muscle group responsible for powerful rotational movement of shoulder) with sword interment.

Considering body height of males in “weapon burials”, this study did not find a positive association between taller stature and the endowment with weaponry in either population, congruent with the findings for male burial wealth in general (see Chapter 6). This is at variance with conclusions reached by other studies of early medieval “weapon graves” (Czarnetzki *et al.* 1983 ; Härke 1992), who mostly argue that “warriors” will have been of taller stature due to privileged conditions from birth and during growth but also due to a “selection” in the recruitment of individuals for warfare-related activities either during the migration period (Härke 1992: 195ff.) or with relation to status. Yet, such a “selection” would imply an element of professional warriorhood (Vandkilde 2006c), while the current findings concur with the social mechanisms uncovered for Pleidelsheim and Neresheim. In a mobile society, in which the burial with weapons can relate to identities other than the direct association with male sex and active warriorhood and which is marked by the notion of achievement of social esteem, rather than ascribed status, such a correlation that associates better health and living conditions with status as expressed by burial wealth would not be expected to be found (cf. also Siegmund 2010: 101). However, one trend observed in these samples hints at a potential significance of a full weaponry set (i.e. five weaponry-types, cf. Chapter 5.3) bequeathed to a deceased male, as in Pleidelsheim, those males tend to be taller on average, while in Neresheim, such a tendency is suggested but cannot be put forward for interpretation as the sample sizes are too small. Considering the previously described association of burial wealth and stature in Pleidelsheim females, it is conceivable that the burial with a *full* weapon set had some affiliation with higher rank and esteem, possibly even an ascription of status and social power.

Considering patterns of skeletal health found among Pleidelsheim 'M W' in the context of all males laid to rest in furnished graves (cf. Table 8.5) as well as of the life course (cf. Table 8.1), only two aspects stand out as characterising males endowed with weaponry, who comprise, after all, 55% of the male cemetery population. One is the age-related incidence of distinct DJD of the right hip which could be established for young middle adult males (see Chapter 6), a significant age bracket for Pleidelsheim males marked by the appearance of a full complement of weaponry and an overall "wealthy" artefact assemblage (cf. Table 8.1), and the first indication of status differentiation. While it can only remain speculation what caused this strong localized degenerative change of the hip, it is accompanied by significant changes of the enthesis of the right *M. gluteus minimus,* distinguishing 'M W' from 'M NW' with regard to entheseal changes observed at middle adulthood (cf. Chapter 7). While this certainly involves an age-related element, similar to the suggested overall comparatively stronger habitual use of the right gluteal muscles and right *M. iliopsoas* in M W for which an association with load-bearing may be indicated, an activity-related patterning common to males buried with weaponry, especially at the onset of middle adulthood, remains a possibility. The observation of a considerable accruement of major entheseal changes in the upper limb, starting with young middle adulthood only in 'M W', as opposed to a continuous age progression of the formation of changes to muscular attachments in other 'burial groups', and the suggestion of slightly varying patterns of entheseal changes in middle-aged 'M W' (see Chapter 7) may hold some indication for males in "weapon burials" to having followed a varying regime of activities different from those of other males. However, the nature of these activities cannot be deduced, considering the great consonance of muscles affected in all male groups, and the age-related nature of entheseal changes. Thus, only very few characteristics set 'M W' apart from 'M GG' at Pleidelsheim, emphasizing the lack of a separate "warrior" group in this population and solely offering insight into a potential age-related *activity* causing the observed skeletal changes, however, without any indication for an association with weapon-use, as the tests for correlations between funerary artefacts and entheseal changes have demonstrated (see Chapter 7).

'M W' in Pleidelsheim are furthermore marked by a comparatively strong exposure to the risk of traumatic injuries, which are, as already mentioned, suggestive of high levels of physical exertion. Yet, more defining is the occurrence of weapon-related injuries, either healed or peri-mortem, uniquely among males buried with items of weaponry, the latter not necessarily associated with an object causing the traumatic lesion (see Chapter 6). While the diagnostic finding of traumatic injuries is not restricted to any particular age category (cf. Table 8.4), the incidence of weapon-related trauma appears to be limited to young middle to mature adulthood (*c.* 26 - 59 years), circumscribing exactly those age categories that were identified as male age thresholds in Pleidelsheim (cf. Table 8.1) and illustrating the emergence of active warriorhood for a number of males within the 'burial group' 'M GG' and a defined age cohort, conceivably in line with social attainment.

This substantiates the interpretation that a "weapon burial" at Pleidelsheim signifies predominantly the *ability* of males to engage in warfare-related conflict, coupled with potential active military service of certain individuals from the pool of males receiving a furnished burial (identified as a probably higher ranking status-group at Pleidelsheim) and particularly weaponry as part of their paraphernalia, as well as with the permeating symbolic notion of weaponry as funerary accoutrements relating to and epitomising male gender and societal standing. The social group of 'M GG' includes individuals that possess an "entitlement for warrior status" (Härke 1992: 219). Not only does this explain the presence of weapon-types in burials of males too aged and probably incapacitated in their ability to engage in fighting, considering the patterns of skeletal health in mature and old adults (cf. Table 8.4), but also the weighty influence of weaponry on the overall "wealth" of a burial as well as the described observations of reception of weaponry items at various stages during the male life course.

As Halsall (2010b: 369) describes for similar weapon burial customs in 6th century Merovingian Gaul, "masculine identity was something that was achieved." In Pleidelsheim, everything points to masculine identity to having been something that *could* be achieved, however, the endowment with weaponry was not imperative to denote male gender. Instead, the mechanisms for weapon endowment in relation to age and ability as well as the observable gradations and different combinations of weaponry found in "weapon burials" hint at an association with both a process of "coming of age" as well as the notion of variable definitions of masculinity, including dominant and subordinate[137] types (Hadley 1999 ; Gilchrist 2009 ; Halsall 2010b), considering that males in "weapon burials" could convey the potent, authoritative, and active man (Treherne 1995). Biologically, no such indications that delineate 'M W' from other males were detected, unless the difference of 'M GG' to 'M NGG' is included. In a society such as Pleidelsheim, where socio-economic status formed an overarching theme in life, the funerary ritual may have displayed the construction of a hierarchy of males with regard to their power and status (Connell 1995, cited in Gilchrist 2009) that may or may not reflect lived reality[138] but that would certainly depict parallels to the fundamental mechanisms of an open ranked society. After all, the values that are commonly and universally associated with "warrior identity", i.e. for instance, loyalty and duty, honour and virtuosity, obedience and comradeship, courage, endurance, strength and potency (Resic 2006), would describe a form of masculinity which not only coincides with the historiographically proposed underlying principles of early medieval Alamannic (?) society (cf. Chapter 3), but also with warriorhood and its components of achievement and social prestige which may either stem from a warfare-active past or the approximation to Frankish idea(l)s[139] in the society of Pleidelsheim.

[137] These two types of masculinity describe hegemonic relationships among males in a society, with "dominant masculinity" describing the more powerful male, vested with a range of proclivities marking his authority, whether physically or figuratively. Other males with less powerful attributes are subordinated by the "dominant" males, their masculinity being shifted closer to "feminine" ascriptions (cf. Hadley 1999 ; Gilchrist 2009: 238, citing Connell 1995).

[138] I.e. the deceased could be merely presented as a warrior by his relatives (Vandkilde 2006c), especially at stages within the life course when age identity over-rides status identity, reflecting on the *familia's* status.

[139] Not warriorhood as such was associated with the Merovingian ideal of masculinity, but the significance of honour, loyalty and glory, which form principal components of the works of Gregory of Tours. Especially the Frankish warrior was likened with "military success and virile manliness" (Van Dam 2005: 206). Interestingly, in Carolingian textual sources (9th century), warriors

The conception of "masculine identity" also impacts on the understanding of the aforementioned principle of "coming of age" that transpires in the life course of a Pleidelsheim male (cf. Table 8.1): a boy turning adolescent turning young man appears to have been already "socialized into warrior ideals" (Otterbein 2004: 6), albeit in this society, the skeletal evidence does not suggest early physical training[140]. If weaponry was used as a major component to engender males, and if the endowment with weapons suggests dominant masculinity (either, for instance, compared to males endowed with grave goods but no weapons, or to the group without any grave goods), then an adolescent male would certainly not yet have achieved this dominant masculine status and therefore was not endowed with weapons before young adulthood, and even then, not the full set, as weaponry would be associated with an achieved, not ascribed, proclivity and status. The potential bestowing with a full set of weaponry with the onset of young middle adulthood, combined with the observed skeletal changes that can be associated exclusively with 'M W', suggests the age of attaining and fulfilling a social role within Pleidelsheim society, whether actively in military service or in position to do so, within the thresholds established from the life course (Table 8.1). The meaning of weaponry in burials might undergo the same shifts as the meaning of social identities reflected in the mortuary rite, and at Pleidelsheim, these movements are entirely related to individuals from the higher-ranking levels of society, despite the absence of a recognisable or definable "élite".

were praised as 'manly', yet those who failed as warriors were not termed womanlike (Stone 2012: 89), while this is indicated in classical literature as well as in Anglo-Saxon sources (Abels 2006). Male prowess had its limits - the *willingness* to fight was expected, yet recklessness was considered as not laudable (Stone 2012: 94).

[140] The idea of early education with regard to future warriorhood and military apprenticeship, including training in weapon handling, in the early medieval period mainly stems from the sources on "warrior culture" in the Frankish aristocracy (e.g. Le Jan 2000 ; Theuws and Alkemade 2000 ; Knüsel 2011).

At last, Neresheim offers different facets also with regard to the concept of "warriorhood". Interestingly, the only biological indicators that point to status-related mechanisms in Neresheim males, more or less directly, are found when considering the group 'M W' more closely, here forming 27.3% of the male cemetery population. Neresheim 'M W' present a pattern of skeletal health that largely concurs with that of Pleidelsheim 'M W', with the exception of weapon-related trauma, which is completely absent in this group. This might be interpreted as an indicator for those having actively engaged in warfare to have been buried elsewhere, but it also poses the question of who these individuals were that are found in Neresheim "weapon burials".

They cannot be contrasted with 'M NGG', considering this 'burial group' only appears with mature adulthood. 'M W' comprises young to old middle adult males possessing those skeletal indicators suggestive of a life affected by hardship and also those which are symptomatic of a physically active life indicating heightened levels of activity-related stress, moreover, already in young adulthood (cf. Table 8.6). This also applies to patterns of activity-related changes as observed from the study of muscular entheses. Patterns of entheseal changes observed in 'M W' are considerably at variance with those of Neresheim males in general[141], not only demonstrating a greater range and variation of upper limb muscular entheses affected by osseous changes (suggestive of a large variety of activities), but also with a strong concentration on the right side and increasing positive correlations

[141] A differing patterning of lower limb entheseal changes to 'M NW' could also be observed, but this pattern is not comparable with PH 'M W' and overall too variable to draw any conclusions other then the implied influence of terrain and variety of patterns of entheseal loading on the lower limbs through activity and age-related changes.

between these muscle groups with increasing age (cf. Chapter 7), which may be possibly due to a range of discrete habitual activities in this ‘burial group’ during earlier life, in combination with age-related changes. Males in “weapon burials” at Neresheim are furthermore the only group in which a positive correlation between entheseal changes of the attachment of the right *Mm. supra- and infraspinatus* and the burial accoutrement ‘sword’ was revealed, which makes sense functionally as the frequent motion of using a sword would involve forceful action of these powerful rotators and abductors of the shoulder and arm (cf. App., Plate A). Changes to these entheses are not only exclusive to males found with weaponry, but also show an onset with young adulthood and subsequent development throughout life, and are significantly more prevalent in Neresheim ‘M W’, compared to Pleidelsheim ‘M W’.

The burial accoutrements for Neresheim ‘M W’ suggests a strong correspondence of (in particular) weapon endowment with active warriorhood as well as male status and masculine identity as defined by "warrior" identity - and so do the skeletal markers of those individuals present in the age categories young to old middle adulthood. The question is whether the phenomenon of exclusively furnished burials within these age categories has to do with weaponry as a marker of esteem, masculinity and achievement - these concepts would assume particular importance in a society in which gender identity was a leading element, therefore over-riding status, the notion of ‘masculinity’ being much more immediate as well as connected with warfare-related achievements and prestige - or whether at middle adulthood, there is a marked absence of males of lower rank (i.e. characterized by an absence of grave goods, relating to the female ‘burial group’ and observed social variances with middle adulthood). This has a lot to commend it - not only the absence of individuals with weapon-related trauma or the increased exposure to physical stress of Neresheim females, but also the biased male : female ratio encountered in this cemetery[142], with a strong preponderance of females potentially representing a further indication for the warfare-related absence of males. As Siegmund (2009) remarks, there are other cemeteries[143], eastern Alamannic or so-called 'Bajuwarian', that show an increased ratio of females, and explanations for this finding are still outstanding. At least for Neresheim, but also for other early medieval societies located more towards the east, away from the Frankish 'centre', it could be argued that warriorhood and the recruitment for active military service are vital components with regard to a man's life, related to the peripheral location of Neresheim and its stronger exposure to hostile attacks and therefore marking a warriorhood related to defence. Meanwhile, the temporary (?) absence of males would, in turn, affect the social complexity at Neresheim and reflect on the aforementioned biological and archaeological "status threshold" at middle adulthood - not only would females have had to perform a greater variety of tasks within the settlement, but, accentuating the gender divide, male absence would have permitted females to increase social interactions relating to and affecting their status and influence within the remits of social roles in their spheres (Arnold 1995). This would contribute to the strong status divide observed within the female group at young middle adulthood (cf. Table 8.6).

[142] This can be established even though not even half of the Neresheim cemetery has been excavated. At Pleidelsheim, the same situation is present, yet there is a near-normal sex distribution ratio (see Chapter 5.1).
[143] Further available data from cemeteries of the Avars (7th - 8th centuries) and Slavs (7th - 9th centuries) also reveal a higher proportion of females than males, especially anthropologically significant in the Avar samples (Siegmund 2009).

The interpretation would also entail, however, that those males recruited or leaving Neresheim voluntarily for engaging in conflict-related activities would have come from the lower echelons of society. Considering diachronic comparisons, this would not be unique, as economic "hardship" presents a perpetual motive for individuals to join military service (Tallett 1997: 93); the strong notion of achievement with regard to status among Neresheim males would, in fact, imply that it was those of lower rank (maybe born into lower ranking families) who would employ warfare-related service as a means of proving themselves, gaining prestige and thus move up socially (Tallett 1997: 98ff.). Parallels for this possibility have been described in only few other studies of archaeological societies (e.g. Sarauw 2007 ; Sastre 2008), considering that commonly, members of the élite would be associated with such a process (Treherne 1995 ; Tallett 1997: 98ff.; Otterbein 2004: 6; Vandkilde 2006b; 2006c), either being the recruited or the recruiting (Nicholson 2004: 39f.). Notions of identifiable gradations in this scheme of status achievement are plausible[144] and could retrospectively explain gradations in weapon endowment in the "weapon burials" at Neresheim, counter-arguing associations with 'masculinity' and the representation of identities and emphasising the general impossibility of categorizing "weapon burials" in relation to social hierarchies (Christlein 1973 ; Steuer 1982a: 309ff. ; Christlein 1991: 83ff.; Nøgård Jørgensen 1997). They could also explain the apparent distinctions with regard to funerary accoutrements and skeletal biology observed with mature adulthood in Neresheim (cf. Table 8.6), at an age when status identity "returns" as a directive for funerary display.

[144] Interestingly, later medieval knighthood is a fine example for such mechanisms: the skills, prowess and nobility associated with knights or "knightly warriors" (Knüsel 2011) is a conception which only emerges for the time after 1300, while before the 11th century, "knights" would have been warriors of lower status, with knighthood remaining an aspiration (Nicholson 2004: 55).

Referring back to Steuer's suggested model of Alamannic society (see Chapter 2.3.2), he does list among the "free" a small group with apparently comparatively low burial accoutrements, "dependants including armed individuals" (Steuer 1997, Fig. 296). Thus, within historical hypotheses, the possibility exists of a lower status grave as designated by its artefactual nature, yet still suggesting an individual with the right to carry weapons. However, there are no evidence-based indications for the proposed model to apply to what the Alamannic individuals within this study represent, and clear demarcations of cogent groups such as "free" or "unfree", as well as a truly discernible "élite", are also absent in this society. Further, the idea that a low-ranking member of a household could be recruited by a higher-ranking one for military service stems from the conferment of circumstances described for later periods and their more hierarchical societies (e.g. the Frankish) that include a strong economic indebtedness and dependency (Nicholson 2004: 40).

In comparison to circumstances at Pleidelsheim, the contradictory trends at Neresheim form a 'burial conundrum'. At Pleidelsheim, active warriorhood appears to have been a *potentiality* (Vandkilde 2006c: 406), primarily for males found among those buried with grave goods, although it cannot be entirely ruled out that it may have been an option for all Pleidelsheim males, even with the present evidence, for a certain degree of social permeability. For Neresheim, the evidence suggests that it may have been an *actuality* for a group of individuals - conspicuous by their absence - while for those laid to rest in the cemetery of Neresheim, active warriorhood appears to have been either a matter of preparedness and ability rather than actual involvement in conflict, and warriorhood identity even more of a lifestyle, associated with higher rank, as well as more of a male status symbol than at Pleidelsheim. It could be hypothesised that the males found with weapons in Neresheim were either present due to the accomplished achievement of certain societal standing, or never "left" the settlement. Instead, perhaps they safeguarded it through their presence, representing members of certain *familiae*, and the weaponry in their burials signifying their potency and high esteem as well as the status of the *familia* which potentially entailed an upbringing that may have involved activities slightly at variance with those of other individuals and the development of the aptness to fight[145].

It can be concluded with some certainty that warriorhood in both societies was not institutionalised in terms of being tied to separate groups of "professional warriors", let alone a "warrior élite" (Vandkilde 2006c), but rather a social identity intertwined with ideology[146], capability, periods of active military service as well as status and age identity, in these two different local societies with differing facets. Warriorhood was not part of the life course for *all* males at Pleidelsheim but both symbolically and functionally attainable for males within a certain socio-economic group, access to it coupled with gender[147] and age identity. At Neresheim, the high levels of social mobility within the masculine gender group and thus the access to warriorhood through the endeavour of gaining prestige and associated personal qualities and merits (Sarauw 2007) makes the possibility more conceivable that some males from this society did indeed participate in retainerships during young adulthood.

[145] A third possibility, albeit extremely conjectural, would be that these males interred in "weapon burials" were not involved in weapon-related activities at all but performed certain occupations that were indispensable for the community. Considering weaponry as a high marker of esteem, they may have been endowed with this type of funerary accoutrement, while indications for actual occupations in Alamannic society are rarely, if ever, found among the grave goods.

[146] in the sense of "contemporary ideal images" (Theuws and Alkemade 2000: 413)

[147] The presence of items that *can* be associated with weaponry in female burials (see Chapter 5.3) may, in this case, lift the gender boundary and make these weaponry-types reflective of status symbols for females.

However, importantly, this cannot be demonstrated for the males whose burials are *present* in this cemetery. Moreover, the findings would deviate from the notion that such admittance to “male clubs” was reserved for members of higher-ranking levels of society (Steuer 1982a ; 1992 ; Vandkilde 2006c), but this may not have been a necessary condition in these non-centralized societies who fall in between “tribes and states” (Steuer 2006).

It seems very likely that mechanisms behind active engagement in warfare-like conflicts applied which can rather be associated with more traditional societies based on kinship, i.e. the mobilisation of men to fight when required in order to defend their own group (Hedeager 1992 ; Vandkilde 2006c). In Gregory of Tours’ narratives, for instance, it is implied that peasants within the Frankish Empire were very well able to fight and defend themselves against attackers who sought to alienate their land or possessions (Greg. Tur. *Hist.* VII.35). This may well apply to the Alamanni of Pleidelsheim and Neresheim, where the overall findings do agree with the notion of “peasant-warriors” (see Chapter 2), however, decipherable in both local societies with very different implications and not incontrovertibly associated with a surmised societal level of a “free man” (Duby 1984: 46; Steuer 1997). At Pleidelsheim, the “warrior” in this quandary may have been more symbolic than active, considering that males from among those buried with grave goods (‘M GG’) may have assumed warriorhood while being, at the same time, active members of the community. Their characterisation then tallies with that of “peasant-warriors”. Yet, males at Pleidelsheim buried without grave goods (‘M NGG’) were peasants. In Neresheim, the “peasant-warrior” can also be encountered in ‘M GG’, but here, it appears that ‘M NGG’ were the “real” warriors.

The question regarding the meaning and significance of weapons as burial accoutrements could be answered for these two Alamannic societies and its importance for recognising social complexities evinced, supporting the increasingly more frequently raised caution that, to paraphrase, weapons in death do not equal weapons in life (Härke 1992: 224), for a variety of reasons. The most important reason being that social organisation and its mechanisms in any society cannot be ignored nor omitted when studying "weapon burials". Ultimately, there is no such thing as "*the Alamannic peasant-warrior"*, just as little as there is "*the open ranked society*" or as there were "*the Alamanni*". All these concepts show as great a variety as the people who lived them.

"All families invent their parents and children, give each of them a story, character, fate, and even a language."
Edward W. Said, *Out of Place. A Memoir*

9 Alamannic life, death, and society: Defining the Unknown

9.1 Conclusion: '*The Alamanni*'? Facets of a population in early medieval Europe

This study has illustrated that "identity" is a matter of great importance to the understanding of societies, especially regarding the period and area under consideration - those centuries following the Migration Period, often merely forming a socio-historical interlude in history books and yet marked by considerable movement of peoples and ideas, and those populations, such as the Alamanni, that lived alongside state societies, the ostensibly "great movers" of Early Medieval Europe. The "rhetorics of the burial ritual" (Theuws 2000: 11) that create identities appear to be all that we have left, yet because they are rhetorics, they can and most often do present the antithesis of what was lived, a "burial conundrum" that not only deconstructs the individual at death (Bazelmans 1999) but elements of lived social complexity, and that, as shown, applies to both the Pleidelsheim and Neresheim cemeteries. Thus, this synthesis of mortuary material and biological evidence (cf. Knüsel 2010) is of paramount importance, as exemplified by the findings of the present study.

While we may still not actually know whether "*their warriors had long hair, dyed red, and liked strong drink"* (Drinkwater 2007: 117), although elements of feasting could be revealed as integral parts of "weapon burials" in both societies (cf.

Chapter 5), this research has placed the archaeological analysis of material culture in new contexts which allow us to create a picture of the lives of *all* Alamannic people, i.e. not only of men and purported 'élites', but of the members - men, women and children - of two local societies of a supposedly homogenous population, which show very different patterns of life and death, as well as of social organization. It was possible to detect different mechanisms of expression of status and identities in burial, as well as to distinguish sets of funerary customs and cultural norms among the two cemetery populations, resulting from varying environmental conditions and showing interesting, hitherto undetected patterns following the transition from pre-Frankish to Frankish rule. Furthermore, the integration of the analysis of patterns of skeletal health and activity from the skeleton, in conjunction with grave goods, acts to reflect the social dynamics in those early medieval communities, the identification of social status and division of labour in a society which has been - historically and archaeologically - considered to have been based on male 'warriorship', almost completely ignoring people's lifeways and interactions.

Reconsidering the key premises upheld with regard to the Alamanni (cf. Chapter 2, Fig. 2.3), this study provides significant insights to either reject or support the following hypotheses.

i) Re: direct correlation between status of the living and equipment of the dead

That the contents of a burial are not tantamount to what characterised an individual in life is amply demonstrated by the present findings and the significance explored for grave goods and burial type. The most pronounced of the numerous reasons that argue for the rejection of such assumptions is the demonstrable influence of social identities onto the funerary rite, as well as the aforementioned “burial conundrum”, i.e. the communal desire to display a state of being different to lived realities. An oversimplifying categorization into “rich” and “poor” or “quality groups” is discordant with the social reality of the Early Medieval Alamannic societies. Especially the case of Neresheim shows that having no grave accoutrements does not automatically equal being poor, but that the burial endowment was associated with the availability of material objects and strongly linked to matters of social identities. The display of a variety of grave goods and distinct gradations among them, leading to the attempt of classification, may only gain some significance when reconstructing elements of social reality within a population that is established in a more hierarchical order, as is the case for the Franks. The developments within the population of Pleidelsheim display initial signs of such patterns with later periods, perhaps owing to a major influx of imports with regard to materials and socio-cultural interactions, while Neresheim remains entrenched in a different form of existence.

The re-assessment of artefact groups made clear that prosaic assumptions about funerary objects are not possible, as there is no ‘universal truth’ about the meaning of grave goods in Alamannic burials, as little as there is about the lives and social behaviour of people in the Early Medieval Period. While customs such as archaeological gender determination have to be abandoned in order to not endanger the evidence-based interpretation of burials, the bioarchaeological investigation could clarify issues such as the significance of “adult grave goods” in sub-adult burials, revealing them to relate to a range of social identities and their implications which also reflect and explain a differential investment in children, even if not much else could be ascertained about Alamannic children in this study.

If the grave goods (and, principally, grave types) mirror anything, it is the variety of people and local societies that made "*the Alamanni*", emphasised by the skeletal evidence, not a unified entity as suggested by the law codes. Importantly, local characteristics found within the burial rite and its display in these cemeteries are not present merely because of a varying "local audience", as Brather (2009: 41) argued in order to vindicate a generalisation of Alamannic life courses and the societal meaning of age and sex; the present results of varying groups regarding skeletal health, living status and activity contradict this notion. Local characteristics were present because Alamannic societies were guided by different principles, living under different requirements that entailed different behaviour, in life and in death. These variances need to be taken seriously if we are to understand the Alamannic populations without trying to engineer them.

ii) Re: societal model of an open ranked society

With Pleidelsheim and Neresheim, we find two Alamannic societies for which the hypothesis of an *open ranked society* as a model for social functioning could finally be endorsed on an evidence-led basis, however, unable to support all the elements upon which Steuer (1982a; 1989 ; 1997) defines it. The evidence suggests that a) there was not only *one* model for such a society, and b) neither the rather hierarchical partitioning nor a three-tier model comprised of a socially leading level, a middling sort, and a low stratum of dependants prevailed (cf. Chapter 2), following the cemetery evidence. Either those socially distinct groups did not exist within an *open ranked society* (especially as defined by legal status, such as “slaves” or “free”), or the present analytical tools do not provide the means for finding these structures. However, while the joint consideration of archaeological and biological indicators could discern certain patterns in the investigated cohorts that provide explanatory power for the mechanisms of the functioning of an *open ranked society* (for instance, the indications for “achievement” endeavours in the burial as well as skeletal record), they could not identify the status categories as mentioned above. This suggests that when investigating *open ranked societies*, much more importance has to be attributed to the identified barriers of social identities that forged them and that testify to much greater mobility and inherent differences in social status and its achievement than is recognised later during the reign of kingdoms. While to this point, the hypothesis that the Alamanni were organised in *open ranked societies* was essentially based on theoretical concepts as well as on often- misconstrued archaeological evidence, this study could reveal some underlying principles of such societal models as well as their different manifestations.

It is arguable whether the gradations observable in the burial evidence, also implied in Steuer’s model for an *open ranked society*, support the tracing of socio-economic distinctions, perhaps more so in a society such as that at Pleidelsheim, where the endowment with or without grave goods appears to indicate a status distinction in itself. However, given the possible association of different ranks within a *familia* as well as among them (Steuer 1982a: 519ff.), it is difficult to postulate any rank order hierarchy on the basis of the present results. Much more revealing, and vital to the detection and definition of *open ranked societies*, is that *different* statuses existed, and which factors governed them. It could be demonstrated that the status or societal rank of an individual cannot be “read” from either the burial evidence or, indeed, skeletal characteristics alone. A predictive element in either type of evidence on its own does not exist.

iii) Re: social mobility

As a leading element of *open ranked societies*, plentiful evidence could be revealed for corroborating this principle in the populations under study. It is of great significance that the bioarchaeological approach proved successful in the exploration and identification of social differences and identities especially in populations like these, which demonstrate high levels of skeletal homogeneity on the one hand and of social mobility on the other, considering the impediments this causes at times with regard to the identification of different groups, especially at Neresheim. Here, environmental influences clouded the diversity that may otherwise have existed and that could be, in its main features, eventually revealed by the careful evaluation of the bioarchaeological evidence. Furthermore, the often very fragmentary state of the skeletal remains complicated data retrieval, and the relatively high amount of grave robbery impeded the bioarchaeological synthesis due to diminished sample sizes that this phenomenon created. Yet, it was possible to approximate a model for social complexity in this population as well, highlighting the viability of considering multiple strands of evidence conjointly.

Not only social mobility itself could be defined, but also status-seeking endeavours and the accentuation of status display in the funerary context could be observed, characterising *open ranked societies* in times of social insecurity but also emphasising the different traits that help to define the overall socio-political inclination of these two Alamannic societies. At Pleidelsheim, mortuary behaviour as well as social complexity reminiscent of Frankish structures may indicate an overall aspiration for legitimacy, in such close proximity to the Frankish centre of power. At Neresheim, a stronger identification as a population ("the Alamanni"?) defending themselves against the Franks or any other hegemony may be visible in the burial evidence. Social mobility in these populations appears to have been ruled by different principles.

Moreover, the present findings describe these principles for all levels and groups of society. The skeletal evidence confirms a certain distinction between those buried in furnished and those in unfurnished graves, influenced by the element of social mobility as much as the material evidence, but it also affords a view on the characterisation of those individuals belonging to any 'burial group', whether classified by gender, age, or socio-economic status. Thus it was revealed, for instance, that active warriorhood was not necessarily restricted to the upper echelons of society (Neresheim), or that it is likely that men of lower status remained active peasants all of their lives (Pleidelsheim). Women are no longer residing in a "gender-neutral" past, spending their days in front of a weaving loom while the men are away fighting, to use the common stereotypes of Alamannic lives. Women certainly had their space, actively, passively, and socially, in these two Alamannic societies, and in very different ways. This study also revealed further insights into the relationship between the sexes, such as on differential patterns of the division of labour between these two groups, providing new suggestions towards gender and population differences that influence the reconstruction of social complexity.

iv) Re: acquired status

Social mobility at Pleidelsheim and Neresheim appears to have been largely based on the acquisition of status, instead of inheriting it by birth - with a few exceptions. Modes for obtaining status could be observed more strongly at Pleidelsheim than at Neresheim. More importantly, this extends to the status of females as well as that of males, the former hitherto considered as mere dependants of the males and hypotheses regarding the acquisition of status thus restricted to the latter. However, females of perhaps higher status at Pleidelsheim include individuals who show a strong indication for maintaining familial status, thus it can be proposed from this study that status was only acquired after attaining a certain age. Its acquisition in adult life was defined differently for males and females, this again more strongly so at Neresheim than at Pleidelsheim.

The evidence strongly supports the suggestion that an Alamannic "élite" was not present in the parts of these cemeteries analysed (cf. Chapter 3). No tradition for an Alamannic élite could be found at Pleidelsheim nor at Neresheim; no group of burials is set apart by either mortuary or skeletal features, i.e. neither by archaeological nor biological evidence. Potentially, we can observe a slow assimilation of higher ranking individuals at Pleidelsheim with Frankish elements indicative of higher status during the course of the 7th century (visible in the material evidence), which may present a natural assimilation process due to Pleidelsheim's involvement in trade, but overall, it is social differentiation observable on a scale that does not permit the identification of an Alamannic nobility in these societies from the 5th to 7th centuries AD[148].

v) Re: significance of 'familia' or household group

The present study substantiates that a social group, whether defined as *familia* or, more generally, as a household, did exist. Its influence is not only perceptible in the funerary display, considering the decision involved in presenting certain aspects of identity for males and females at Pleidelsheim and Neresheim, but is also attested with regard to the question of attained versus inherited status and the social roles of individuals, in particular those of females. Thus, bioarchaeological research on social identities and their communication in the funerary rite offers another way of approaching the existence and significance of such societal elements, apart from the hitherto often attempted analyses of biological or archaeological interdependencies (for instance, the cohesion of burial clusters within a cemetery, or anthropological kinship analysis (e.g. Alt and Vach 1994 ; 2005; Jørgensen *et al.* 1997)). Of course, this recognition of the element '*familia'* is conceptual and not based on demonstrable ties uncovered within a cemetery, but it is nonetheless of high importance to the comprehension of social relationships and the interpretation of the burial display in Alamannic cemeteries.

[148] It is interesting to note, however, that one child's grave at Neresheim (Skel. NE 2, cf. App. 4, Table 4), that of a boy who passed away during early childhood and whose burial was dated to the turn of the 5th to the 6th century, was endowed with an exceptional number of artefacts, which may indicate the presence of a high-status *familia* towards the early stages of this settlement who used this burial display to express their status, just before or around the official onset of Frankish rule.

vi) Re: the Alamannic "peasant-warrior"

The results of this research provide the means by which to deconstruct the myth of the 'Barbarian warrior' in the heart of Europe during the Early Medieval Period. Just like the general notion of the Alamannic "peasant-warrior", this construct comes to a swift demise when investigating all aspects of the "weapon burials" at Pleidelsheim and Neresheim. The surveyed aspects of 'warrior identity' in its relational and social dimensions and its associations with masculinity as well as socio-political and economic realities, and thus potential requirements and appeals of active military service, make warriorhood for the Alamannic man as little "Barbarian" as for any other population in history. The "peasant-warrior" was certainly no universal concept, another generalisation to be reconsidered when discussing the Alamanni. What can be stated from the evidence from Pleidelsheim and Neresheim is that the "warrior" was a lived identity for the Alamanni, but not a lived reality for all Alamannic men. There is a discernible difference between active warrior status and warriorhood as a social identity, and even in the latter, we recognise different facets to the fabric of this identity, as the analysis of the Alamanni examined in this study has indicated.

The present findings bear great significance also beyond the Alamannic and Merovingian context, as the variety and, again, influence of political, economic and social determinants within a society were illustrated as highly influential in the interpretation of "weapon burials". It is vital to abandon assured assumptions about individuals buried with weapons (cf. also a similar call by Härke (1992)) if early medieval societies want to be fathomed in their variety and composition. Neither can those individuals be straightforwardly considered as "high status" individuals, nor as males (in the absence of an anthropological sex determination), even though weaponry generally denotes the male in Alamanni cemeteries. Furthermore, we cannot perforce expect to find active warriors in the cemeteries we investigate and should therefore refrain from unsustainable assumptions about those males found in "weapon graves".

This research affects the development of bioarchaeological analysis of Alamannic cemeteries in a number of ways. We have to leave the tradition of the 'grand narrative'. Historical, archaeological, sociological and anthropological approaches have to communicate in order to recognise the Alamanni, who, at least in earlier periods, were just as diverse as their ethnogenesis suggests, and this diversity should be embraced by archaeological research, not curtailed in a bid to categorize and align them to somewhat better chronicled periods before and after the Alamannic "dark ages" of the 5th to 7th century. The exploration of social identities has to be more relational, as they are closely entwined and dependent on one another. The same applies to artefacts and skeletal remains. What once formed a unit in the funerary context should not be taken apart by independent scientific inquiry if the aim is to interpret the whole. Of course, neither archaeological nor skeletal evidence are without perils of interpretation[149], but the whole being more than the sum of the parts, the patterns uncovered in this study by bioarchaeological advances strongly suggest that the mechanisms revealed with regard to social

[149] For instance, deviations in skeletal age resulting from drawbacks in skeletal age-at-death determination methods (Aykroyd *et al.* 1999) may change the significance of some thresholds established in the life course, however, the analysis of cohorts rather than individuals, choice of multifactorial age-at-death determination methods and use of broad age categories as used in this study address such limitations.

identities and complexity in those two populations are elements of Alamannic reality and pave the way for further discourse.

9.2 Future Directions

This study has provided a population- and group-based analysis addressing the identities of cohorts defined by communal coherence, gender and burial endowment. An interesting next step will be the composition of **osteobiographies** of individuals seen within the construct of social organisation and the knowledge gained on the meaning of grave good groups. Such osteobiographies ("life history as recorded in bone" (Saul and Saul 1989: 288; cf., for example, Robb 2002 ; Knüsel *et al.* 2010 ; Zvelebil and Weber 2012)) would underline the diversity of those populations, but also focus on individuals, perhaps further enlightening social identities unique to each local society, as matters such as status and the 'social persona' can only be further addressed by such in-depth consideration. The construction of such osteobiographies is only valuable in the aftermath of this study, as the real importance of individual members of society depends on the needs of their society[150]. This is an aspect of social identity, of the 'social persona', that could not be focused on in the present study but will further enhance our knowledge of the people living at Pleidelsheim and Neresheim in future research. Furthermore, the role of individual artefacts in the construction of social identities, within an osteobiographical approach, needs to be explored.

[150] See, for instance, *Ælfric's colloquy* (10th/ 11th century; Garmonsway 1991), in which agricultural activity (i.e. the ploughman) is indicated to be the most valuable skill, as it feeds the people.

More specifically and pertaining to the exploration of individuals in “weapon burials”, the inclusion of **asymmetry studies** coupled with an in-depth study of weapon-use and indications of activity-related patterns provided by entheseal changes could provide a more defined picture of not only further differentiations within the “weapon burial” groups, but also of the applicability of such biomechanical studies on archaeological questions.

The inclusion of **isotopic analysis** is a logical step in order to complete the investigation into status-related differences with regard to dietary patterns and, possibly, geographical movement. This has been already instigated (Schutkowski and Speith 2011) and will primarily approach the question of whether in a society perceived to be relatively homogenous diet reveals patterns of differentiation which support those suggested by the funerary and skeletal evidence.

Overall, the analysis of further well excavated, if not, ideally, **complete Alamannic cemeteries**, using similar approaches, would provide a better understanding of societal complexity and practices within *Alamannia*. An adequate comparison of groups was often not possible due to small sample sizes, therefore any augmentation of studied cases is beneficial in order to not oppose incomplete or one-sided textual evidence with fragmentary funerary evidence. Furthermore, a **comparison of several sites** and deciphering of the significance of geographical location (i.e. environmentally for influences on patterns of physical health and activity, politically for influences on societal functioning and responses) is desirable. Such a study would permit further investigation of the question of early medieval “warrior societies” by evaluating, for instance, whether the character of “warriorhood” encountered at Neresheim extends to other Alamannic settlements further away from the influence of Frankish powers, and would aid in answering the question of whether Neresheim did resist hegemonisation, or whether their potential involvement in warfare was instead related to participation in Frankish calls to arms.

Diachronic comparisons of societies by ancillary bioarchaeological studies in other regions of the early medieval world dispense with a pre-occupation with trying to model social organisation of state hierarchies and later medieval systems onto early medieval populations. Also, the importance of **transitional changes** has to be re-investigated and re-considered - regional variation cannot be dismissed. Continuing research into the consideration of **identities and their complexity** as a means for bioarchaeological interpretation offers viable insights into the synthesis of biological and cultural information from the funerary record. Finally, and more in general, the continuing **instigation of the bioarchaeological and thus integrated approach**, including further development of techniques for investigating activity-related markers and entheseal changes as well as the application of skeletal biology to archaeological questions, closes the circle of this study by maintaining the call for more interdisciplinary collaboration to avoid interpretations based on circular reasoning.

The potential for Alamannic and early medieval archaeology is immense, as the analysis of data can be taken in a variety of directions, from methodological to theoretical considerations of social archaeological and culture-historical research and their points of contact, or from specific questions such as the emergence and permanence of warriorhood identity and its changes, to more general matters such as the usefulness of social identities for the exploration of formation of states and societies as well as for assessing their visibility in the archaeological record. Bioarchaeological analysis and socio-historical synthesis make it possible to considerably deepen our comprehension of early medieval societies and to gain fascinating insights into the lives of people who did not leave more than their mortal remains.

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